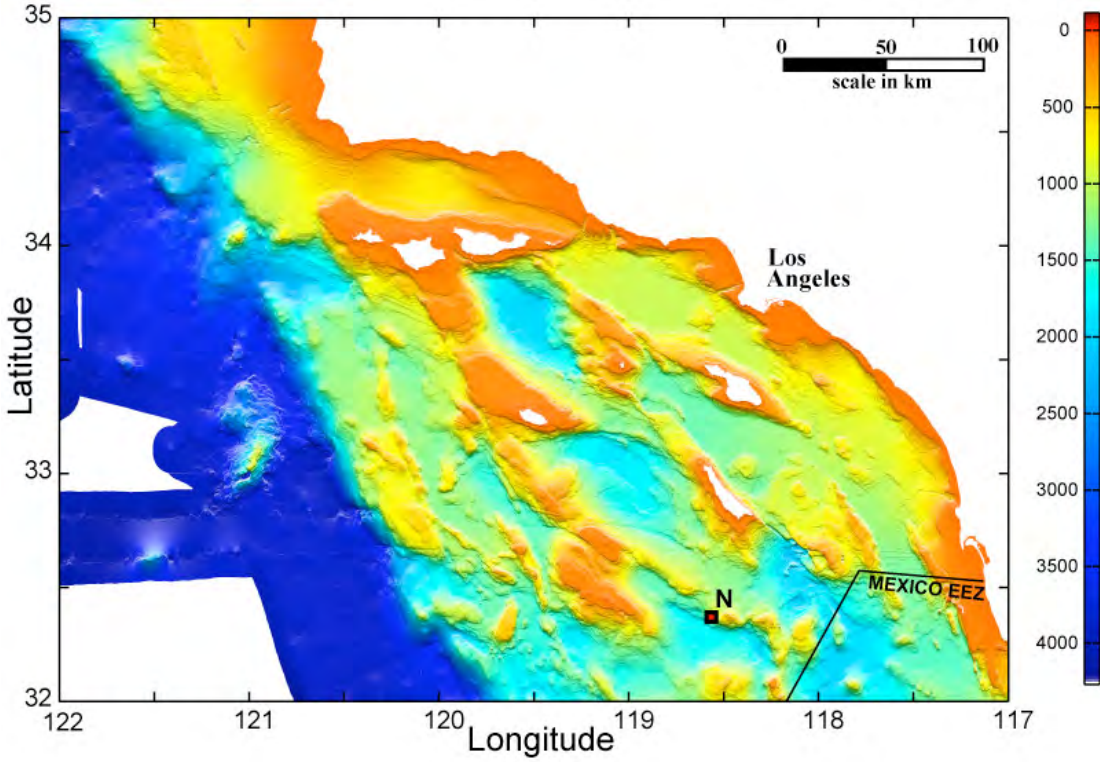
Marine Physical Laboratory of the Scripps Institution of Oceanography University of California, San Diego

SCRIPPS Whale Acoustics

High Frequency Acoustic Recording Package
Annual Data Summary Report
March 14, 2009 – March 26, 2010
SOCAL Site N



John Hildebrand, Hannah Bassett, Simone Baumann, Greg Campbell, Amanda Cummins, Sara Kerosky, Mariana Melcon, Karlina Merkens, Lisa Munger, Marie Roch, Lauren Roche, Anne Simonis and Sean Wiggins

Marine Physical Laboratory, Scripps Institution of Oceanography
University of California San Diego, LA Jolla, CA 92037-0205

Contract Numbers: FISC N00244-08-1-0028 and FISC N00244-10-C-0021

Project Title: Southern California Marine Mammal Studies

Location: Site N, Latitude 33°22 N, Longitude 118°34 W, approx. Depth 1300 m

Deployment Cruises: SOCAL 32-37, R/V Sproul

Recording Period: March 14, 2009 – March 26, 2010

Sample Rate: 200kHz Recording Interval: Continuous

Summary

This report summarizes the underwater sounds detected during a series of deployments of a High Frequency Acoustic Recording Package (HARP) in the southern California (SOCAL) offshore region. The HARP records broadband (10 Hz – 100 kHz) acoustic data, including both marine animal and anthropogenic sound. This report summarizes initial analysis to detect the presence of marine mammals by species as well as the occurrence of naval sonar and other anthropogenic sound events.

The HARP deployments were conducted at site N, located south of San Clemente Island (Latitude 33°22 N, Longitude 118°34 W, approx. Depth 1300 m), an area of naval training activity. The HARP at site N was deployed and recovered by the R/V Sproul during cruises SOCAL 32 (March 14, 2009) through SOCAL 38 (April 11, 2010). It recorded acoustic data continuously at a 200 kHz sample rate with data gaps in-between deployments, resulting in a total of 325 days (7744 hours) of recording over a period of 377 days. Table 1 provides a summary of HARP deployment dates, locations, and recording times.

We investigated the temporal occurrence of marine mammal and anthropogenic sound using manual analysis of three frequency bands: 10-1000 Hz (Low); 1000-5000 Hz (Mid); and 5-100 kHz (High). For each of these bands one or more analysts scanned the data using a long-term spectrogram display with approximately one hour of data per display. A MATLAB based software package called *TRITON* was used for data display and event logging. Potential sound events detected in a one-hour or shorter spectrogram were investigated at finer temporal scales to identify the origin of the sound by species or type of anthropogenic sound. Table 2 gives a summary, by species-call type or anthropogenic sound source, of the number of hours and days which sounds were detected, as well as the percentage of hours or days they were detected.

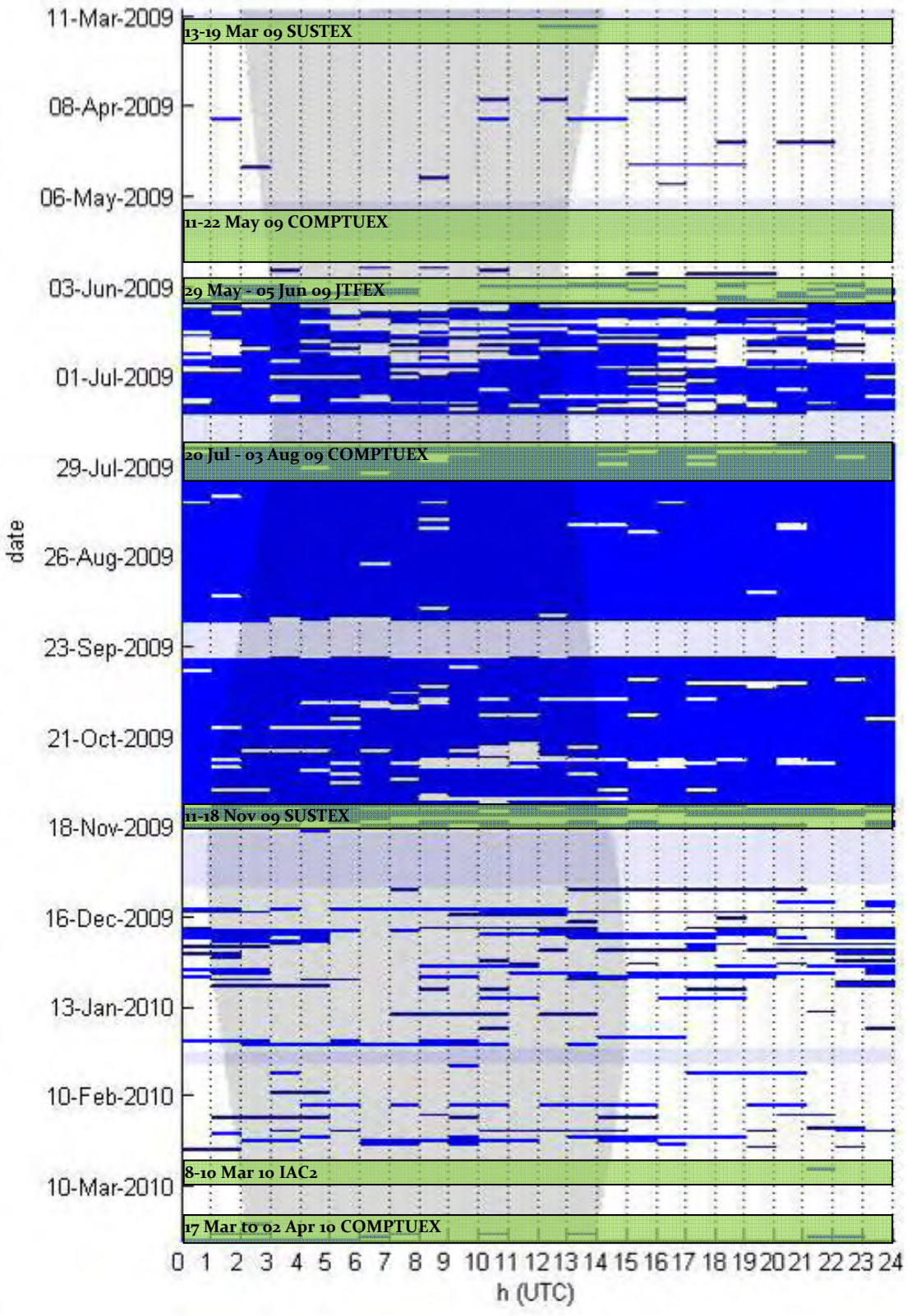
The detections for each call type or anthropogenic sound are also presented as a series of plots below. Sound detections are represented as a solid bar in hourly or minute bins, with each day of data along a horizontal line. Nighttime is indicated in a darker transparent color, and periods of off-effort (no acoustic data) are shown in light blue. Detected marine mammals include: blue whale, fin whale, unidentified whale, Bryde's whale, minke whale, humpback whale, sperm whale, killer whale, unidentified beaked whale, "43 kHz" beaked whale, "50 kHz" beaked whale, Baird's beaked whale, Risso's dolphin, Pacific white-sided dolphin, unidentified odontocete, and pinniped. Anthropogenic sounds include mid-frequency active sonar, echosounder, ship noise and explosion.

Table 1. HARP Deployment Dates, Locations and Recording Times.

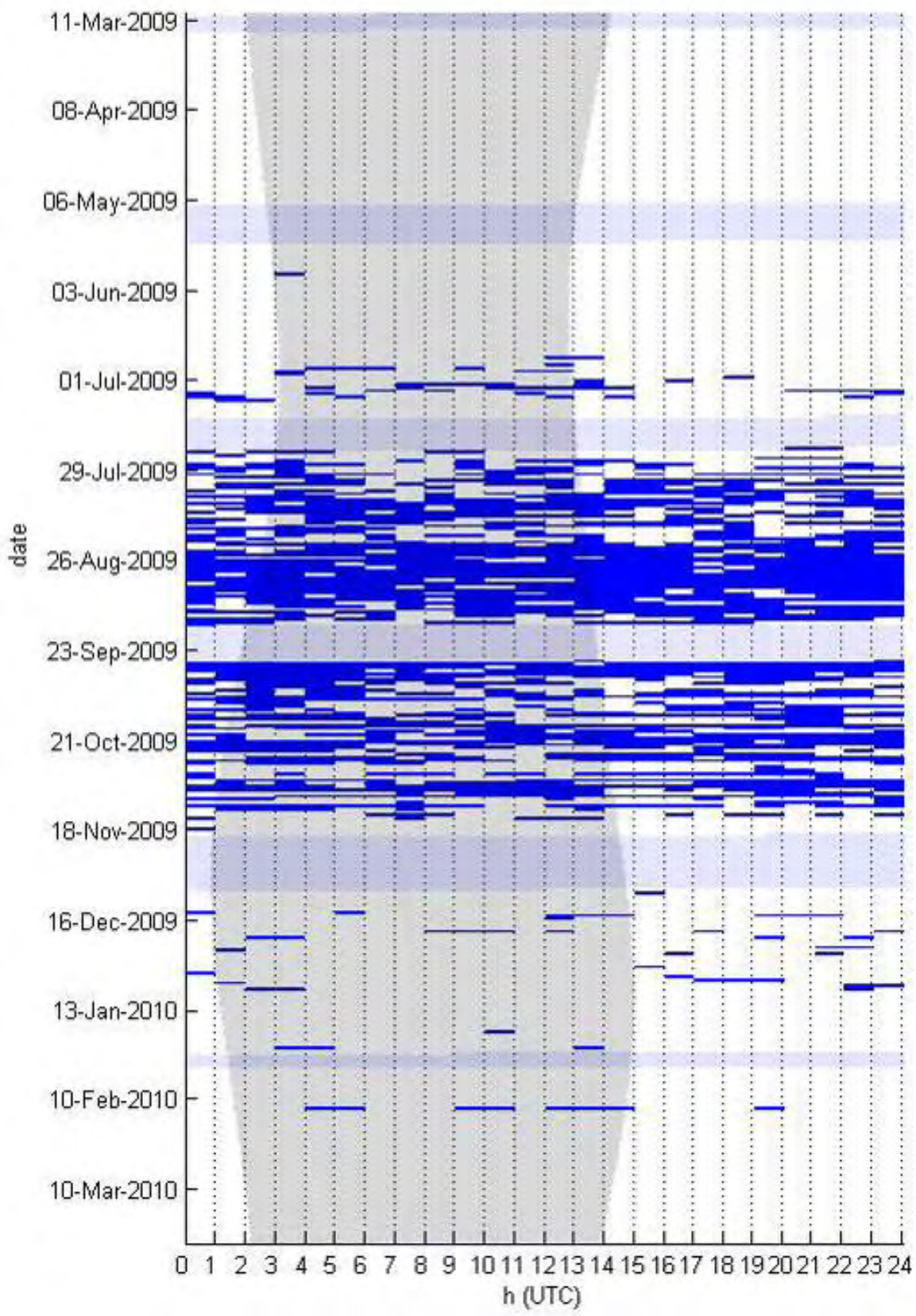
Site/ Cruise	Deployment Date	Recovery Date	Deployment Latitude N	Deployment Longitude W	Depth (m)	Recording Start	Recording End	Days	Hours
SOCAL32N	3/14/2009	5/19/2009	32-22.205	118-33.905	1295	3/14/2009	5/7/2009	54	1302
SOCAL33N	5/19/2009	7/22/2009	32-22.197	118-33.893	1295	5/19/2009	7/12/2009	54	1302
SOCAL34N	7/22/2009	9/25/2009	32-22.186	118-33.885	1287	7/22/2009	9/15/2009	55	1303
SOCAL35N	9/25/2009	12/6/2009	32-22.191	118-33.887	1295	9/26/2009	11/19/2009	55	1313
SOCAL36N	12/5/2009	1/30/2010	32-22.186	118-33.769	1282	12/6/2009	1/26/2010	52	1221
SOCAL37N	1/30/2010	4/11/2010	32-22.184	118-33.768	1280	1/31/2010	3/26/2010	55	1303

Table 2. Detections of Marine Mammal Species and Anthropogenic Sound Sources.

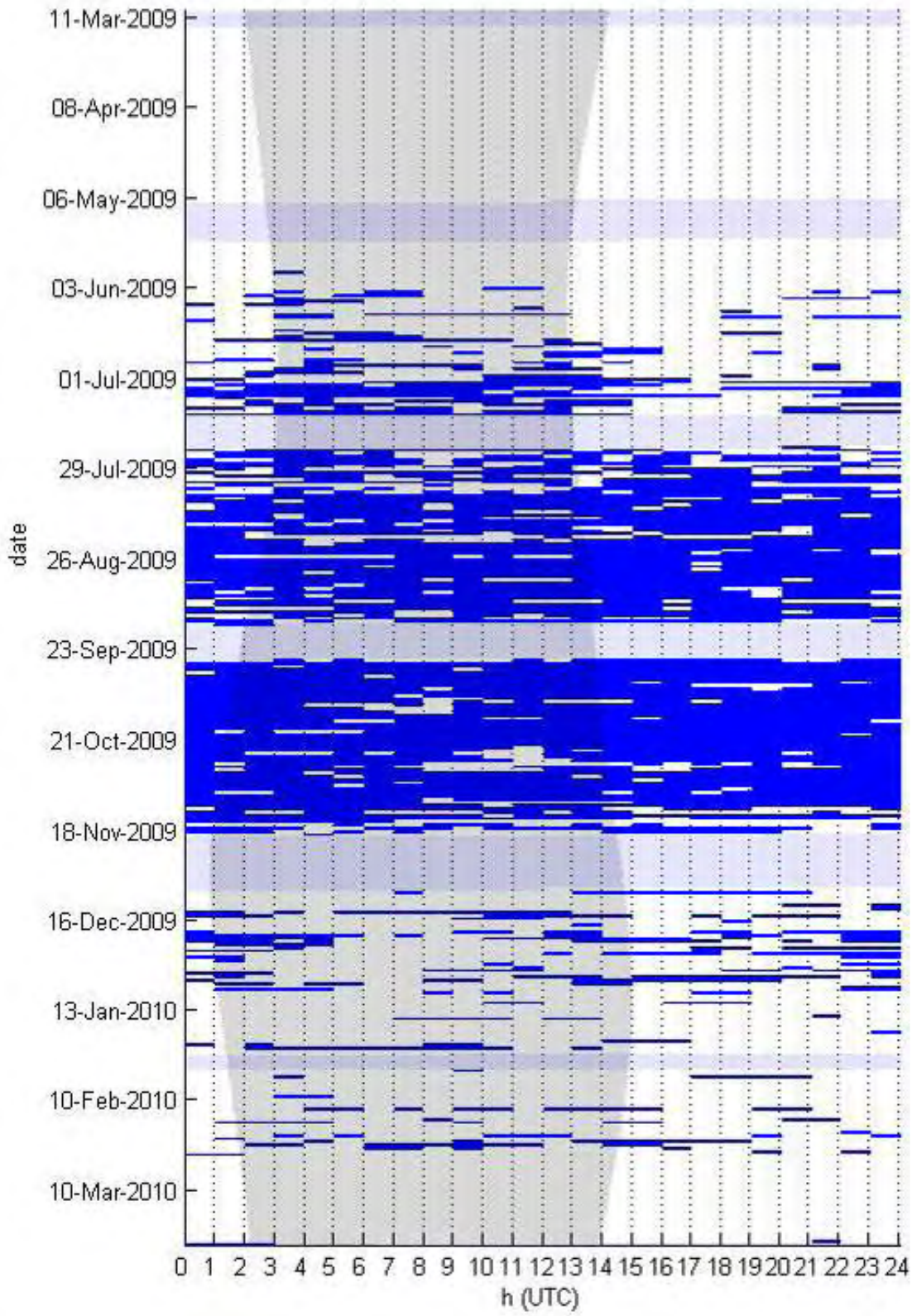
Species/Source	Call Type	Hour Bins	Percent Hours	Daily Bins	Percent Days
Blue Whale	All	3362	43	217	67
Blue Whale	A	1574	20	139	43
Blue Whale	B	2674	35	201	62
Blue Whale	D	1677	22	146	45
Blue Whale	Song	530	7	93	29
Fin Whale	All	5848	76	322	99
Unidentified Whale	50 Hz	872	11	224	69
Bryde's Whale	All	245	3	50	15
Minke Whale	All	2	0.03	2	1
Humpback Whale	All	1548	20	209	64
Humpback Whale	Song	472	6	105	32
Odontocete	Clicks	4548	59	325	100
Sperm Whale	Clicks	65	1	18	6
Killer Whale	Whistles/ Clicks	19	0.2	10	3
Unidentified Odontocete	Low-Freq. Whistles/ Clicks	41	1	18	6
Beaked Whale	Clicks	882	11	259	80
43 kHz Beaked Whale	Clicks	2	0.0	2	1
50 kHz Beaked Whale	Clicks	5	0.1	5	2
Baird's Beaked Whale	Clicks	18	0.2	12	4
Risso's Dolphin	Whistles/ Clicks	91	1	37	11
Pacific White-sided Dolphin	Whistles/ Clicks	49	1	26	8
Pinniped	All	25	0.3	18	6
Anthropogenic	All	4462	58	325	100
Anthropogenic	Mid-Frequency Active Sonar	816	11	131	40
Anthropogenic	Echosounder Ping	258	3	81	25
Anthropogenic	Ship Engine Noise	3914	51	320	98
Anthropogenic	Explosion	252	3	94	29



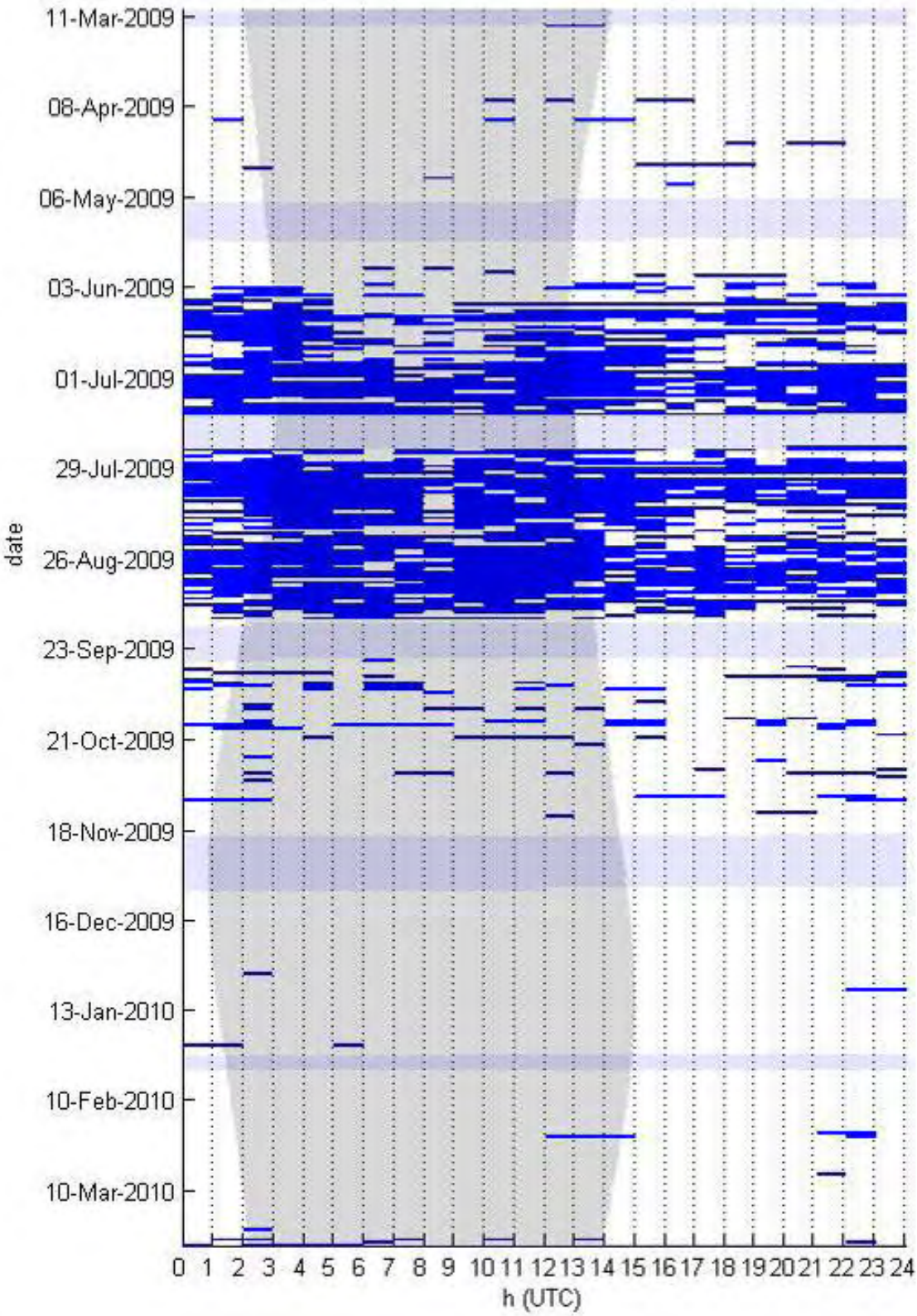
Blue Whale – All Call Types in Hourly Bins



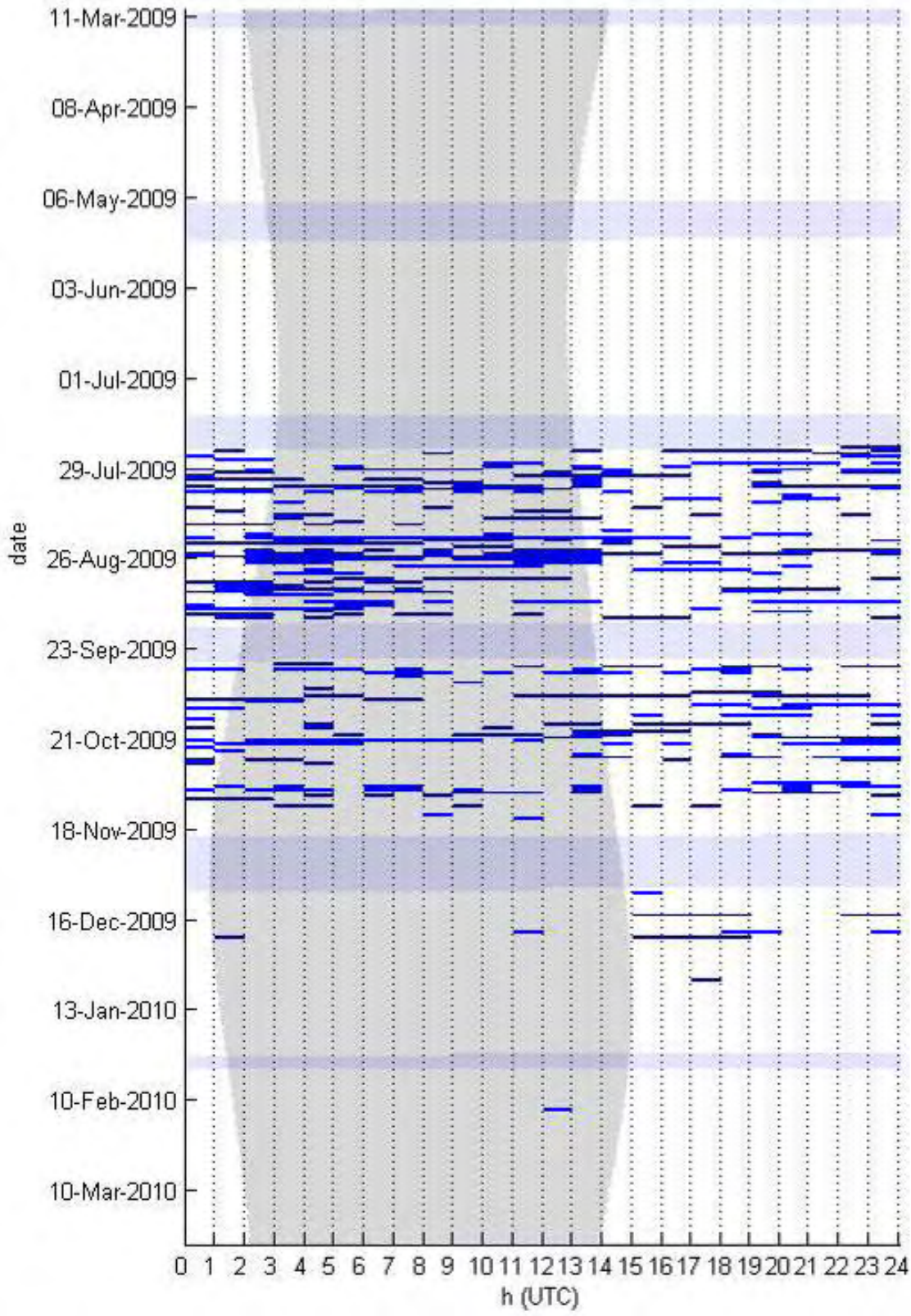
Blue Whale - "A" Call in Hourly Bins



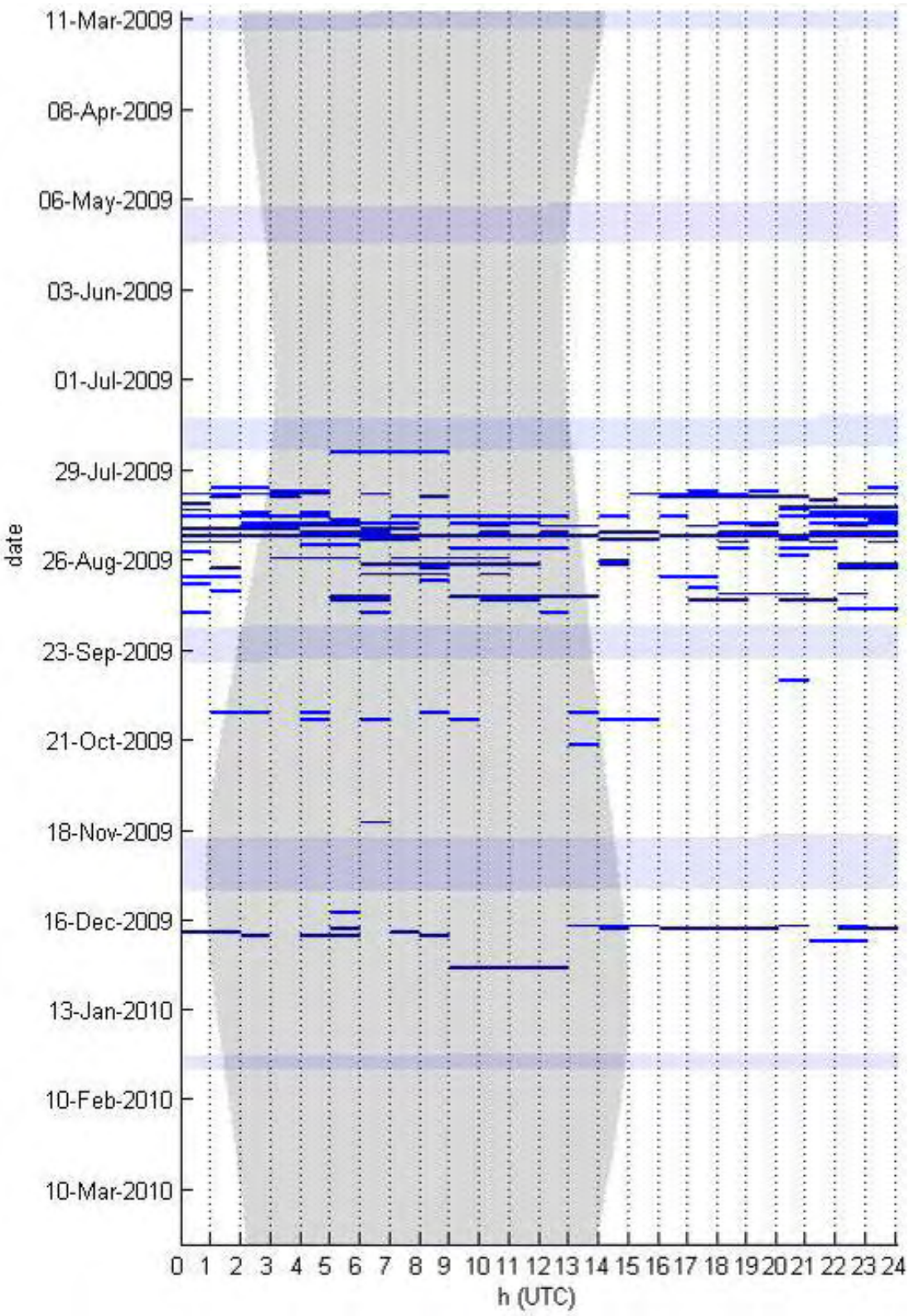
Blue Whale - "B" Call in Hourly Bins



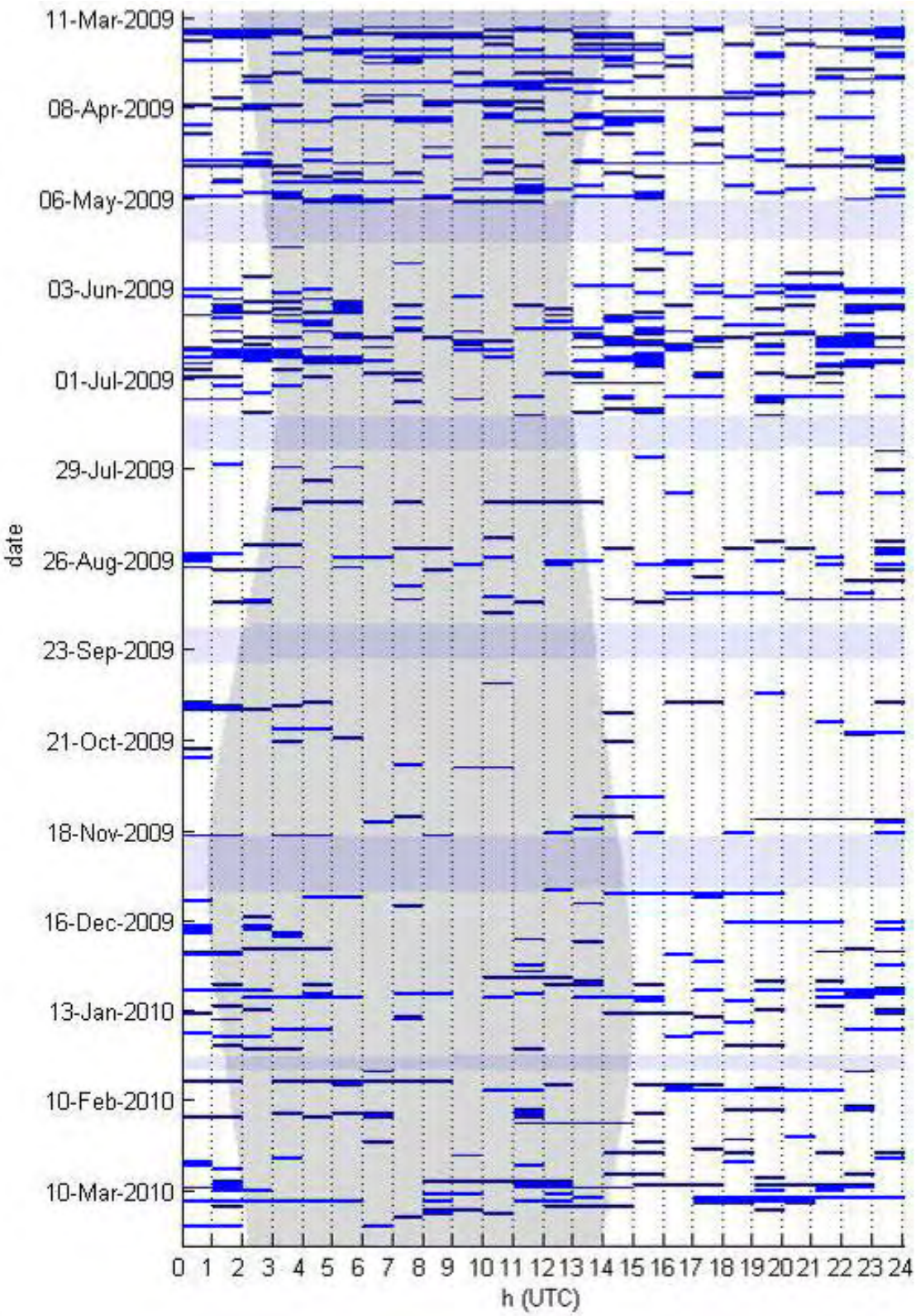
Blue Whale - "D" Call in Hourly Bins



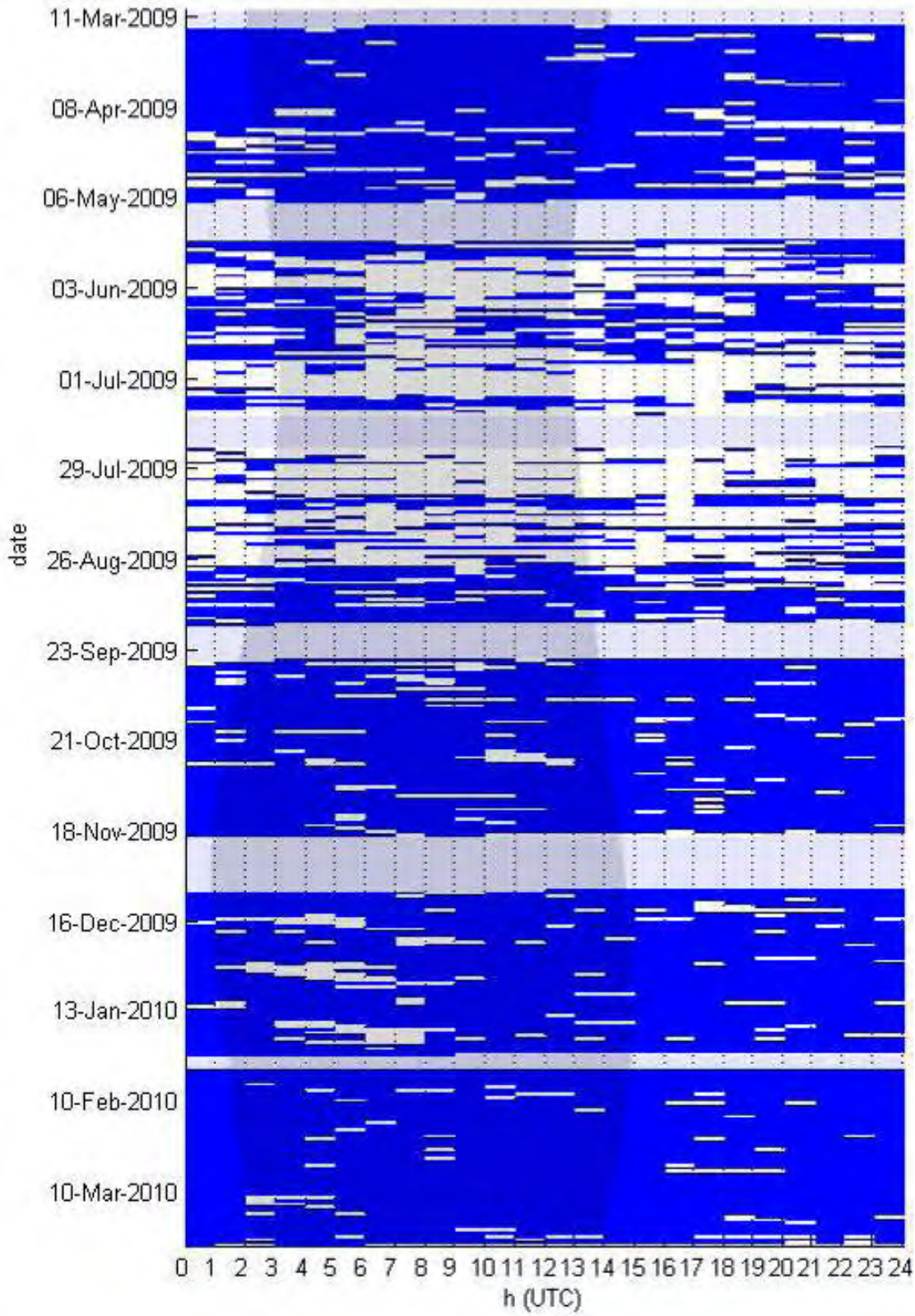
Blue Whale - Song in Hourly Bins



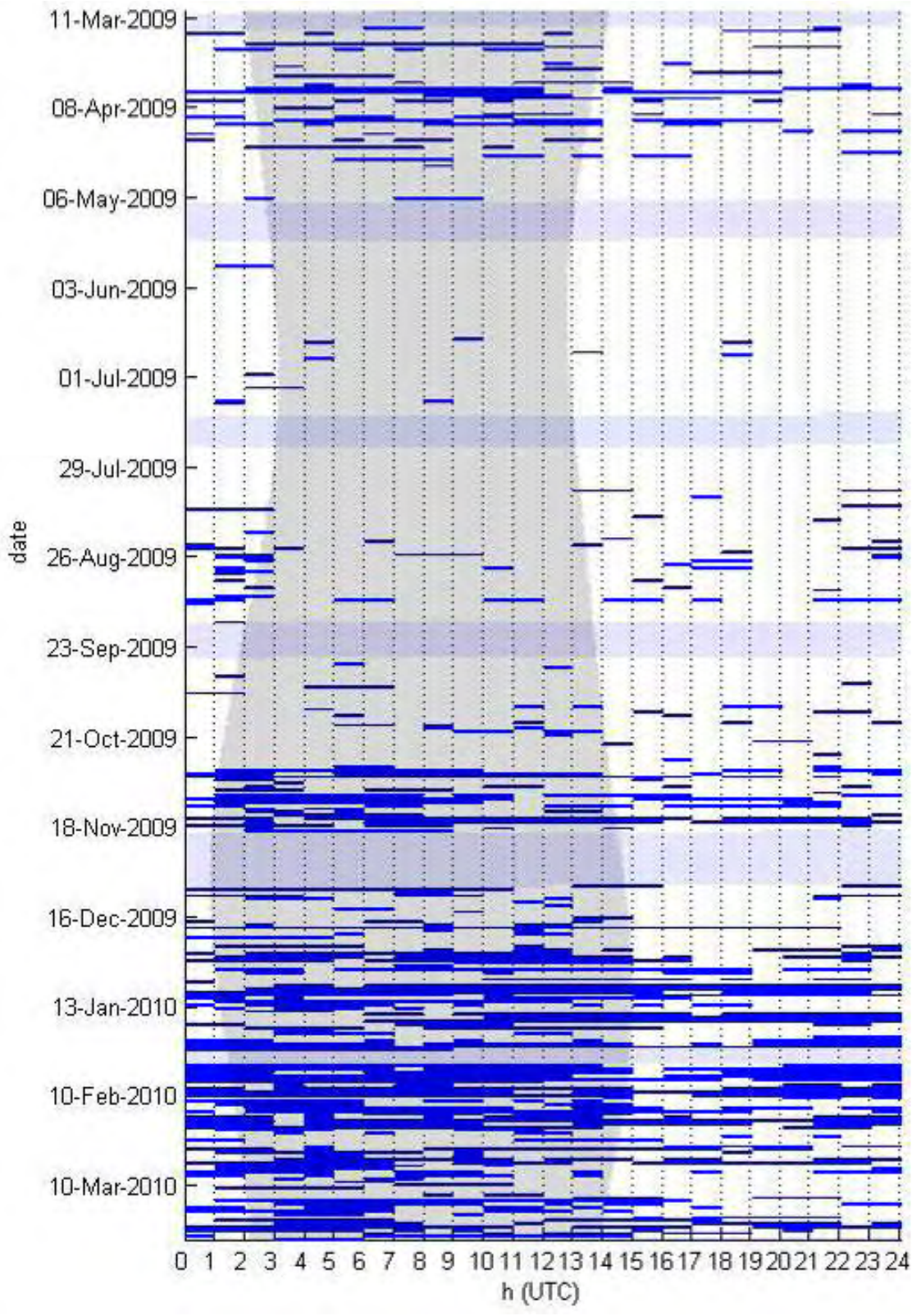
Bryde's Whale – All Call Types in Hourly Bins



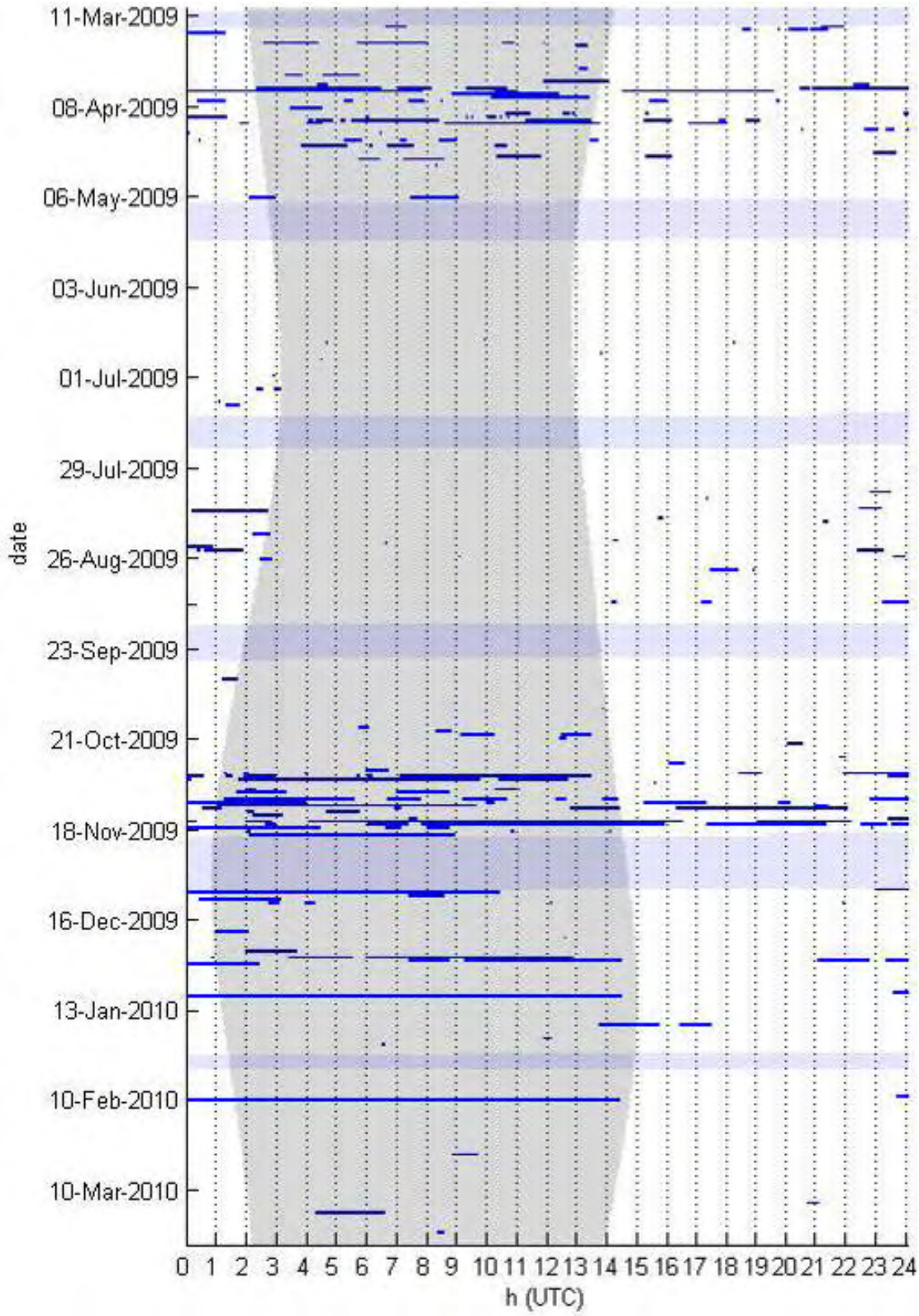
Unidentified Whale - 50 Hz Call in Hourly Bins



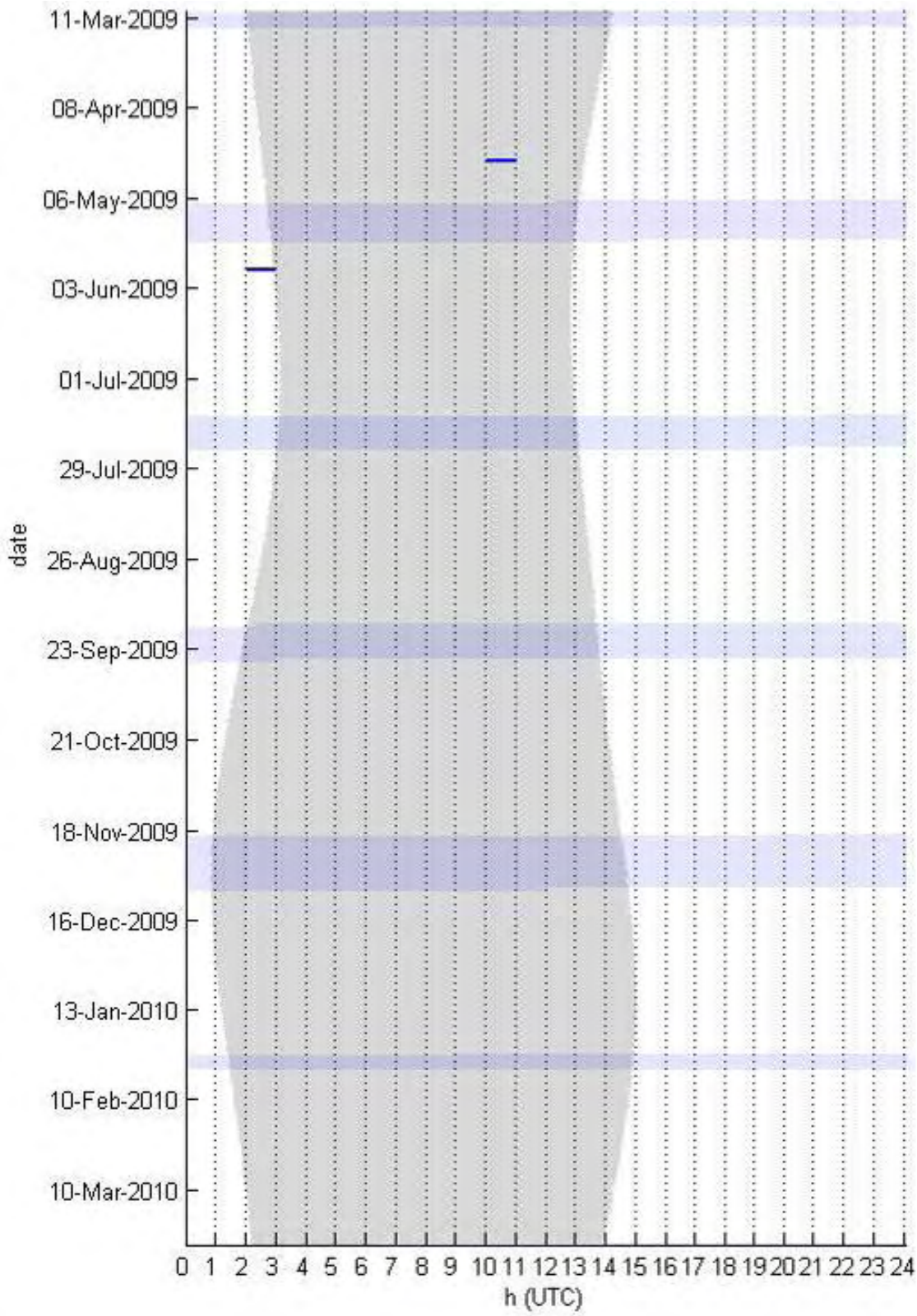
Fin Whale - All Call Types in Hourly Bins



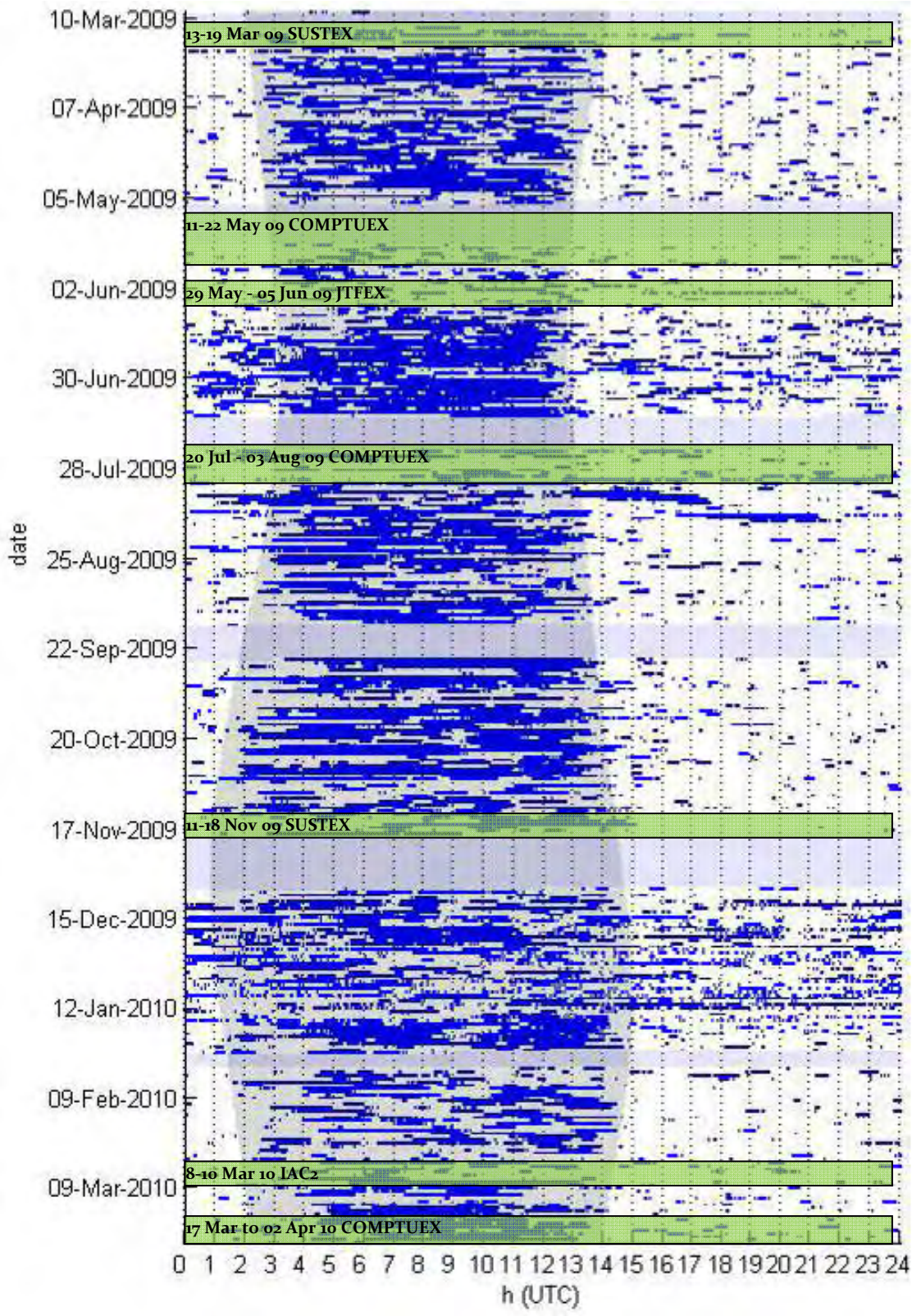
Humpback Whale - All Call Types in Hourly Bins



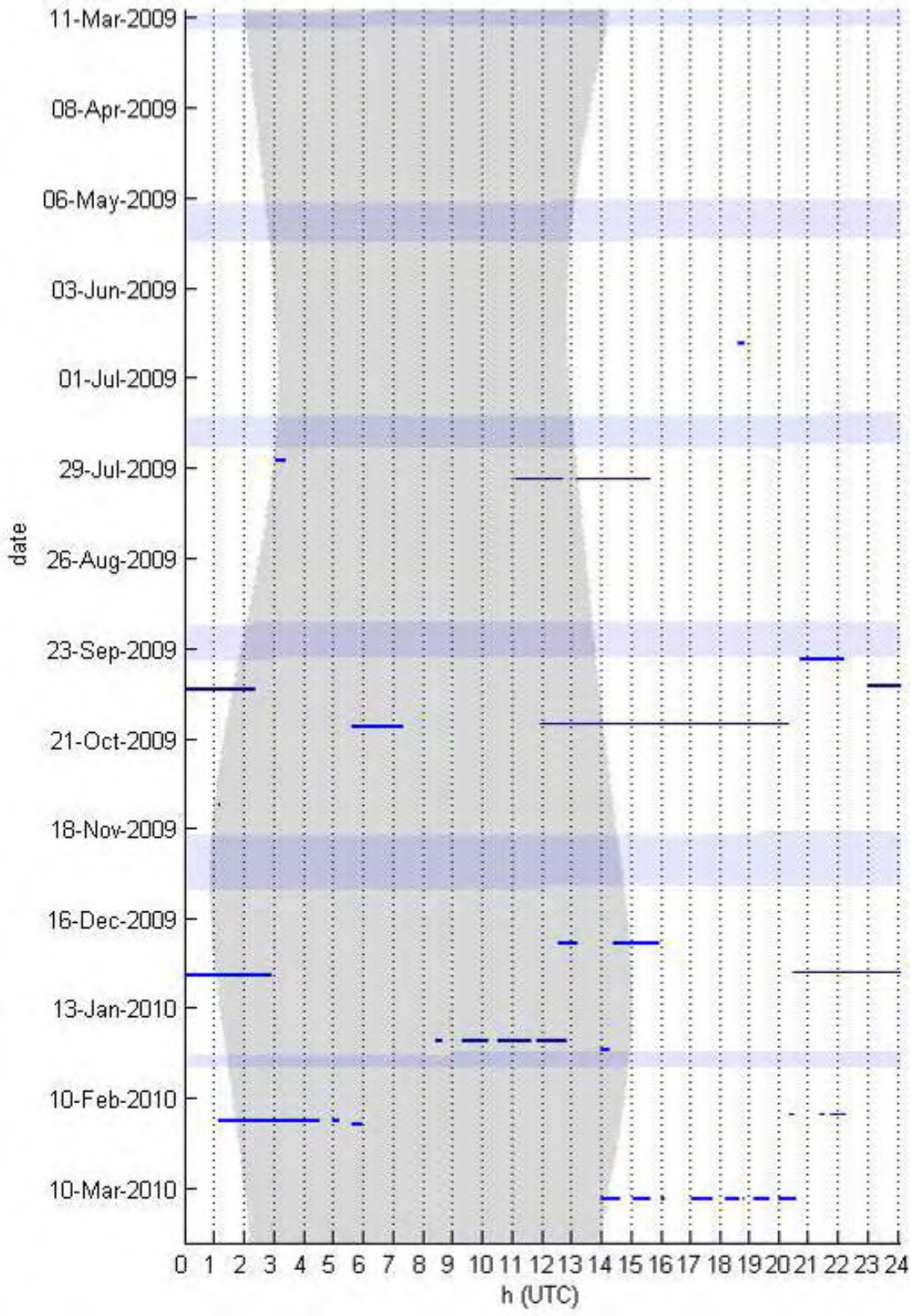
Humpback Whale - Song in One-Minute Bins



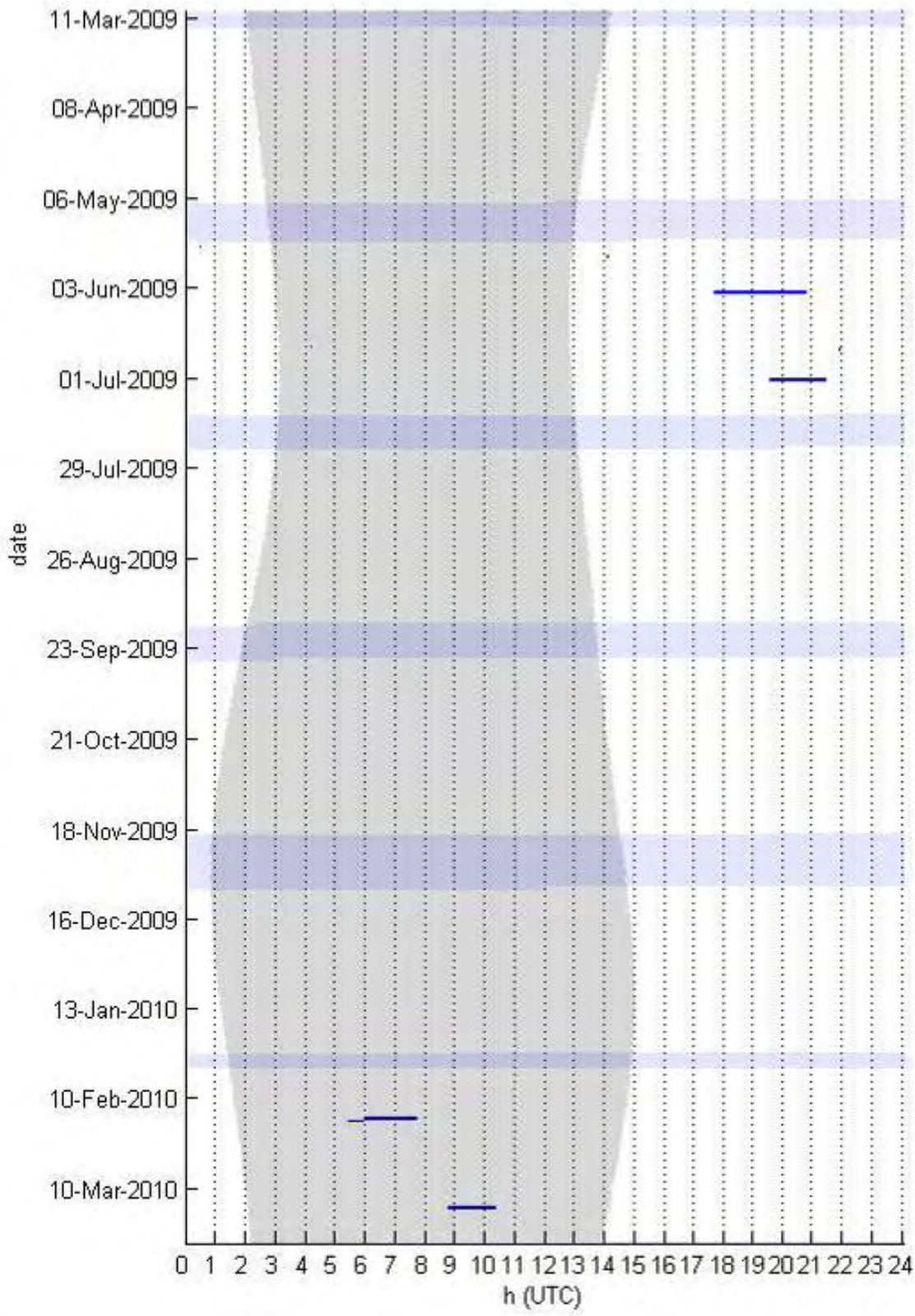
Minke Whale – All Call Types in Hourly Bins



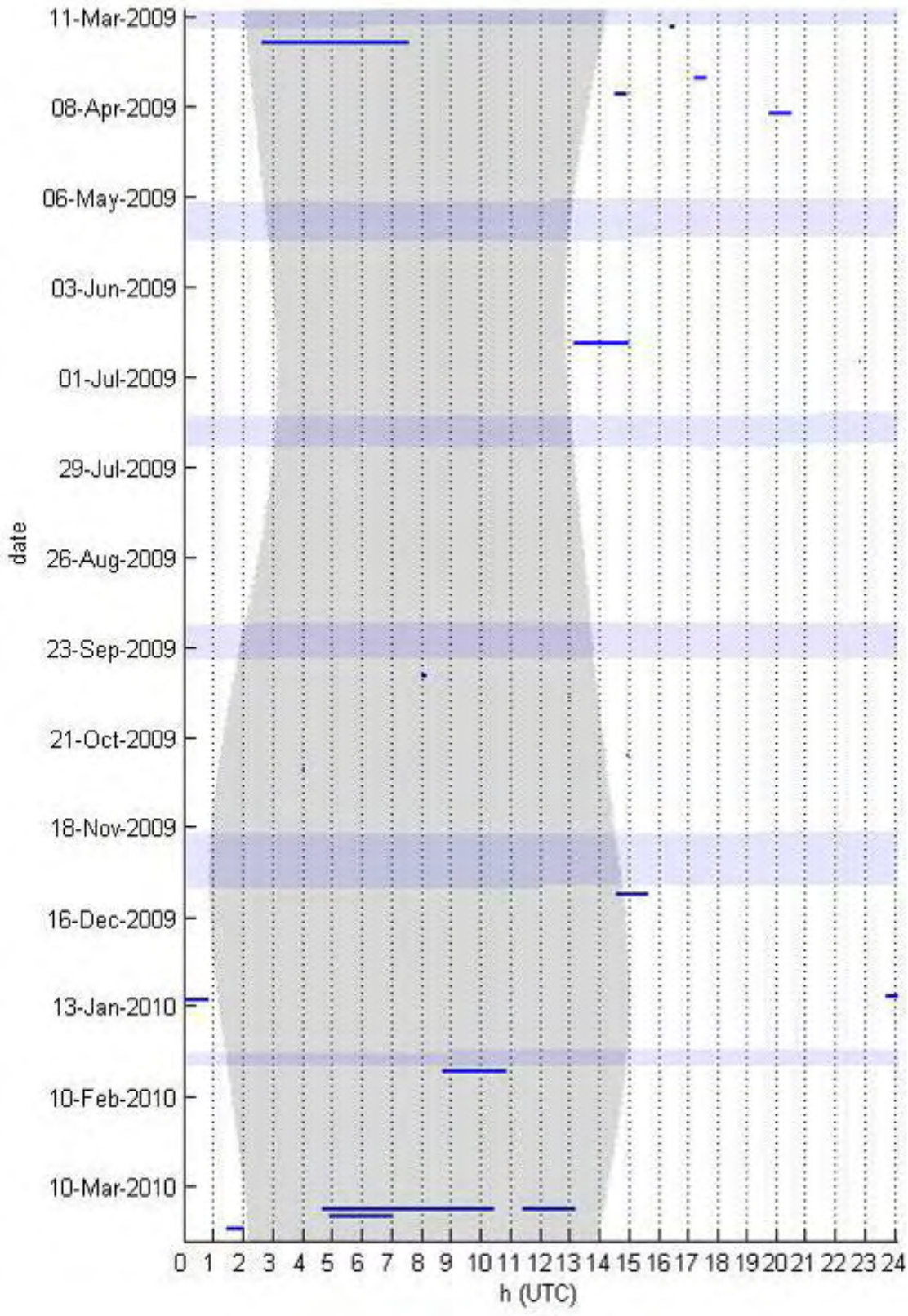
Odontocete - Echolocation Clicks in One-Minute Bins



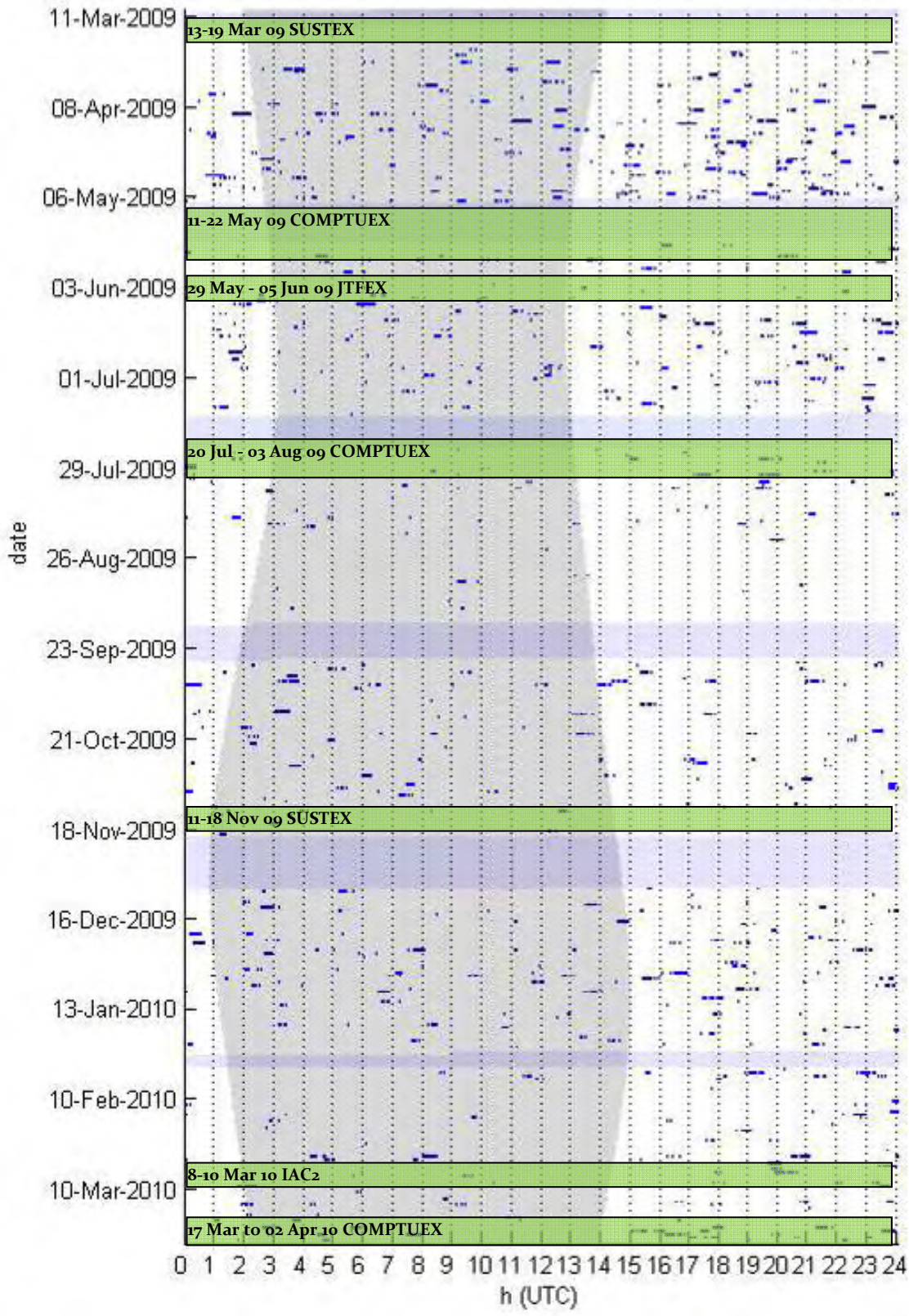
Sperm Whale - Echolocation Clicks in One-Minute Bins



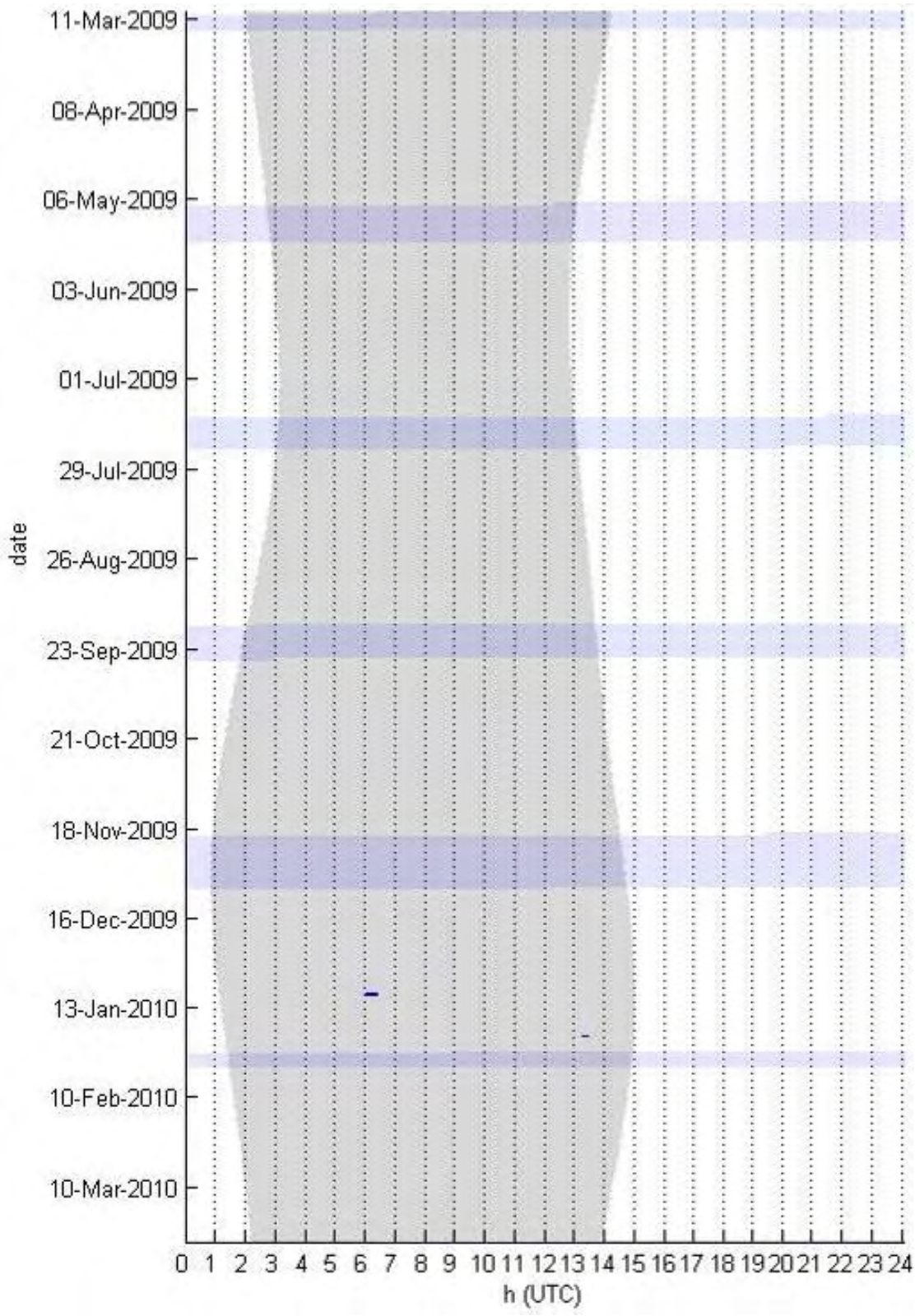
Killer Whale – Whistles and Echolocation Clicks in One-Minute Bins



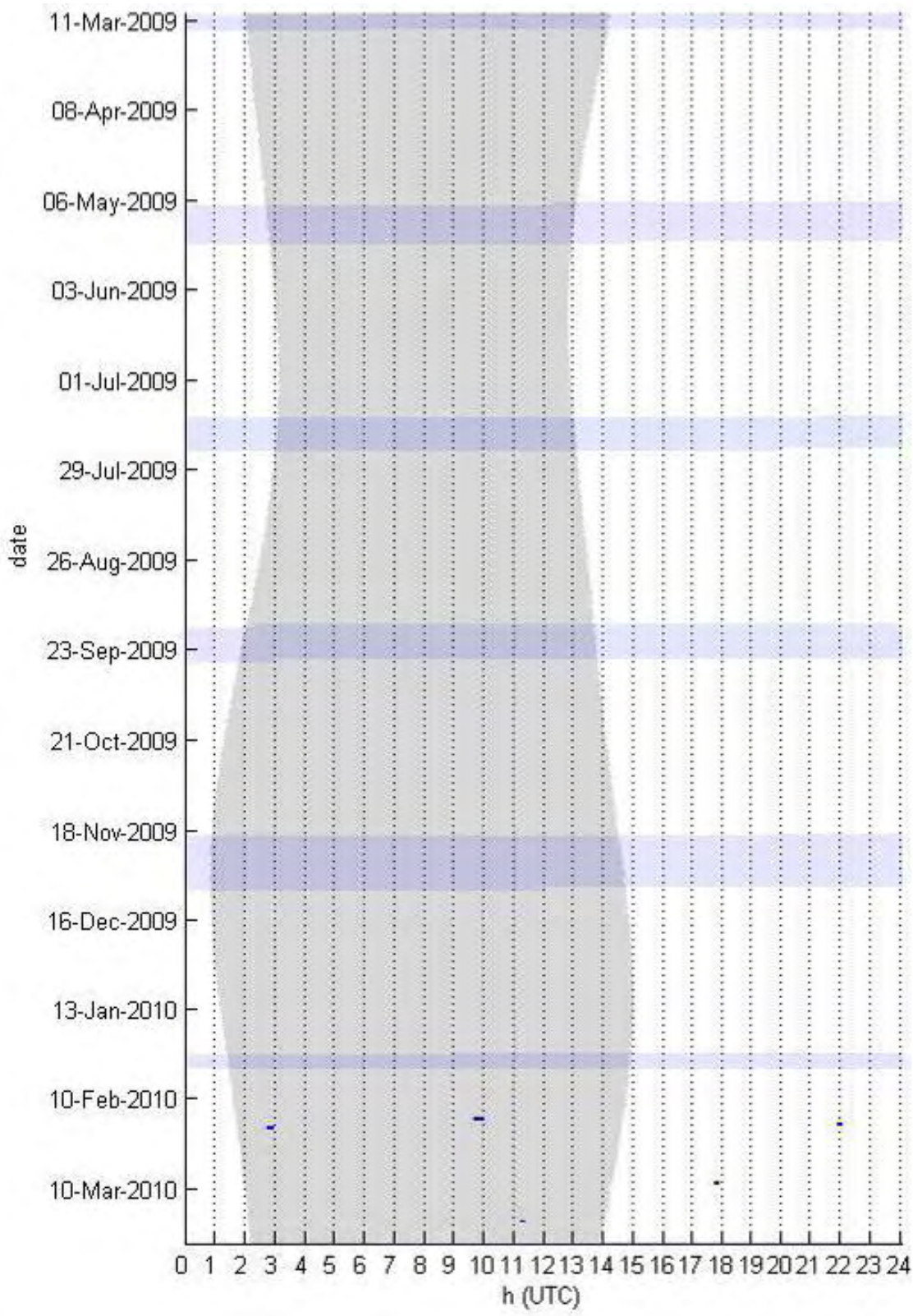
Unidentified Odontocete – Low-Frequency Whistles and Echolocation Clicks in One-Minute Bins



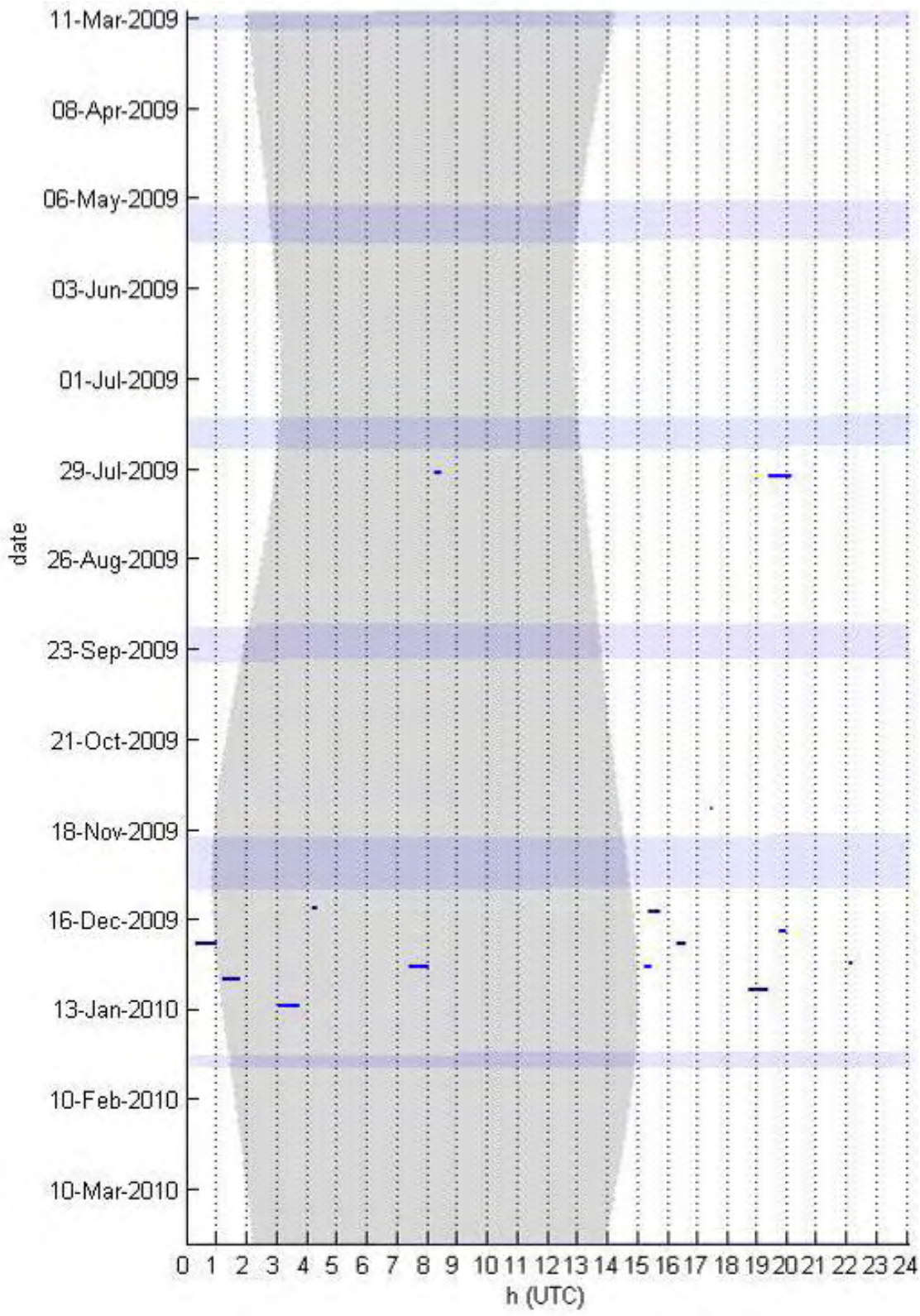
Beaked Whale - Frequency-Modulated Clicks (20 kHz < Peak Frequency < 55 kHz) in One-Minute Bins



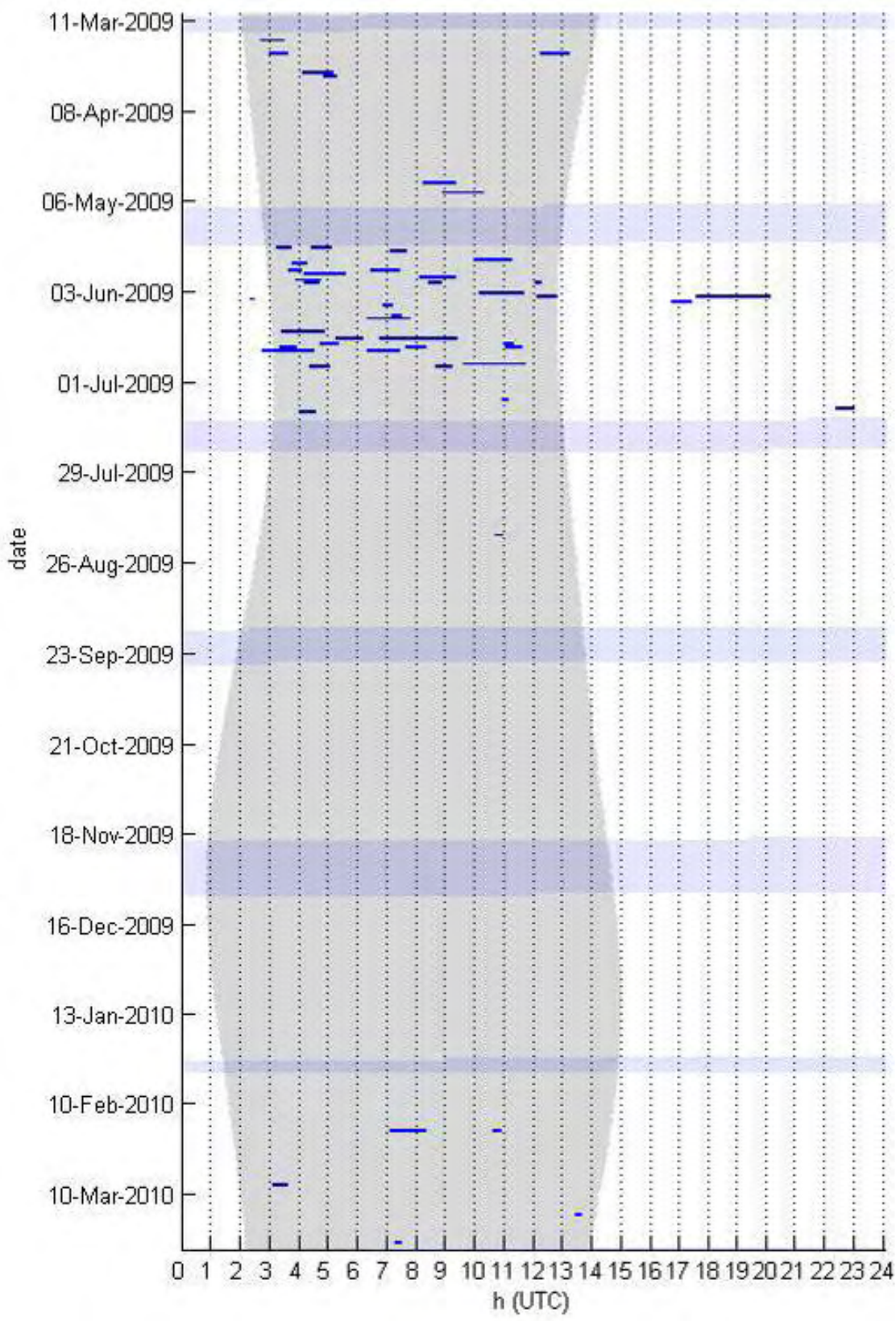
43 kHz Beaked Whale - Echolocation Clicks in One-Minute Bins



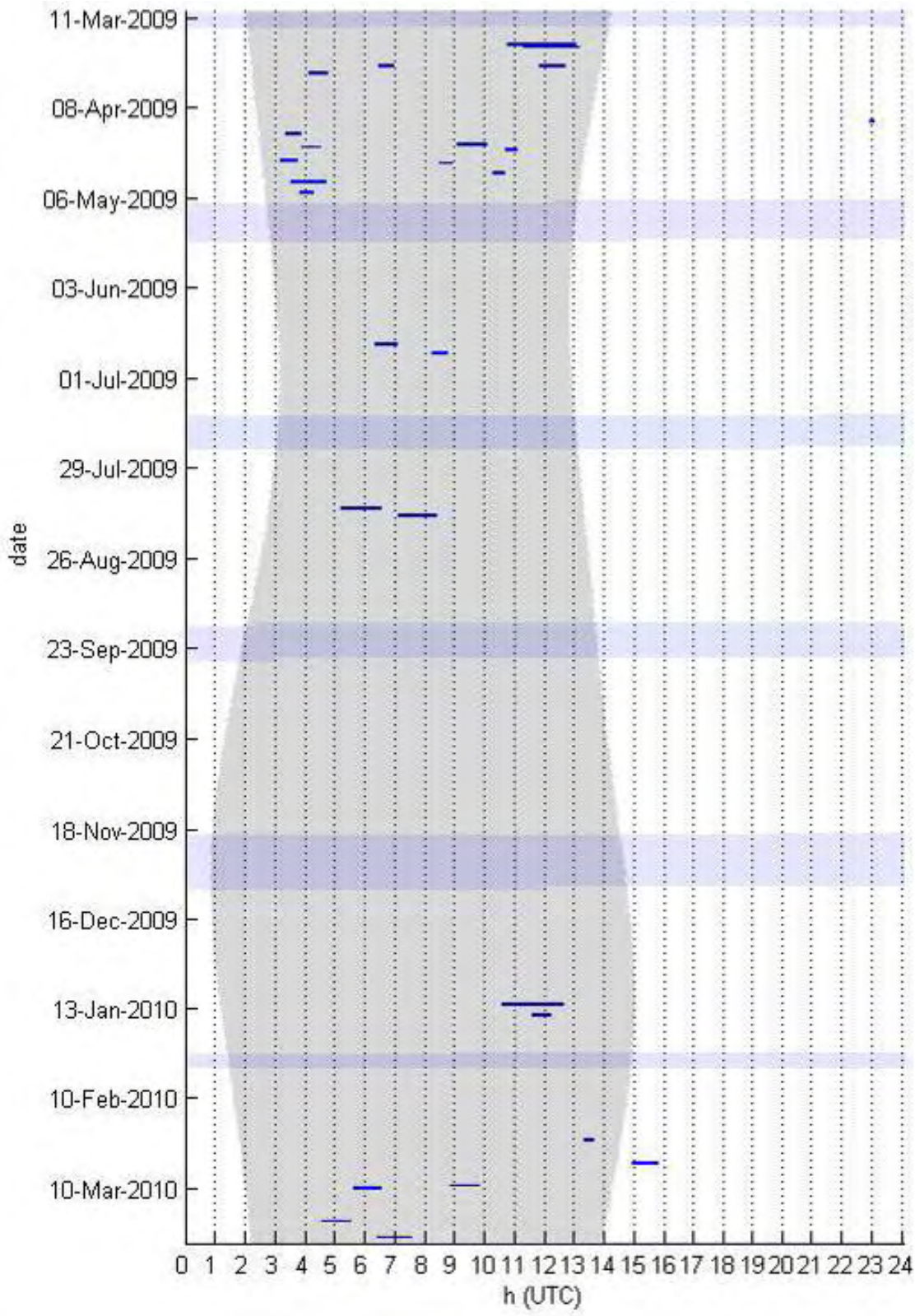
50 kHz Beaked Whale - Echolocation Clicks in One-Minute Bins



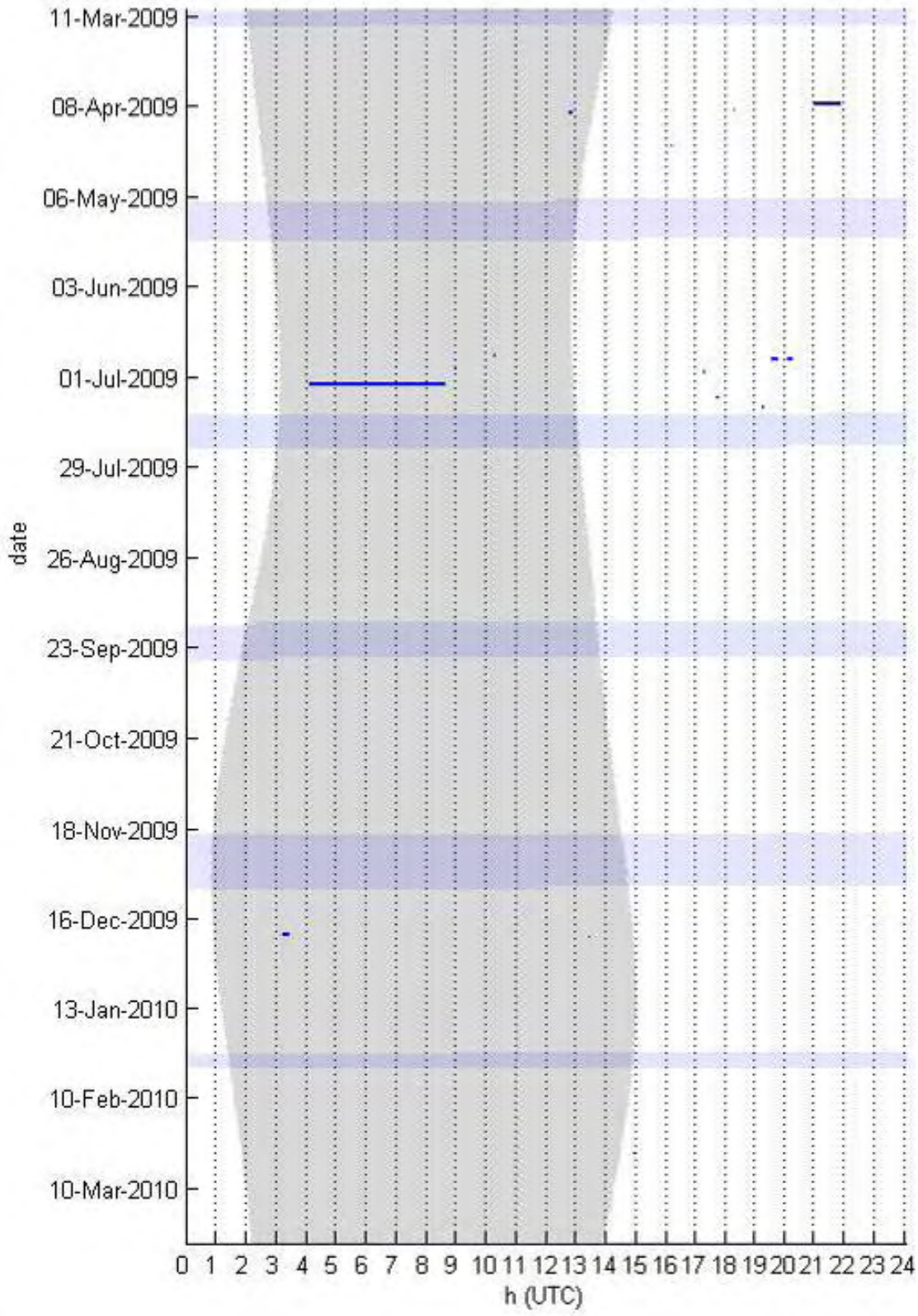
Baird's Beaked Whale - Echolocation Clicks in One-Minute Bins



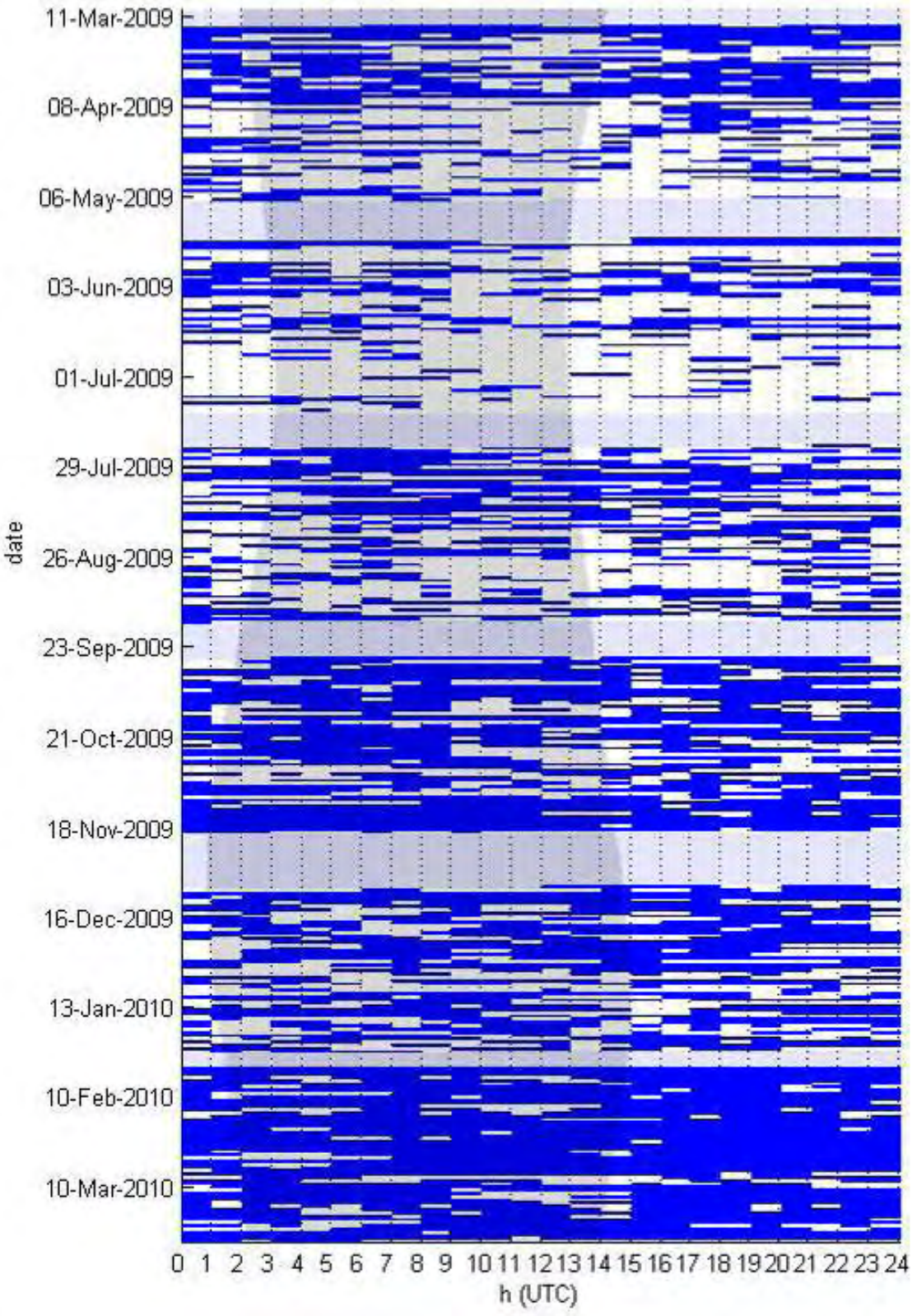
Risso's Dolphin - Echolocation clicks in One-Minute Bins



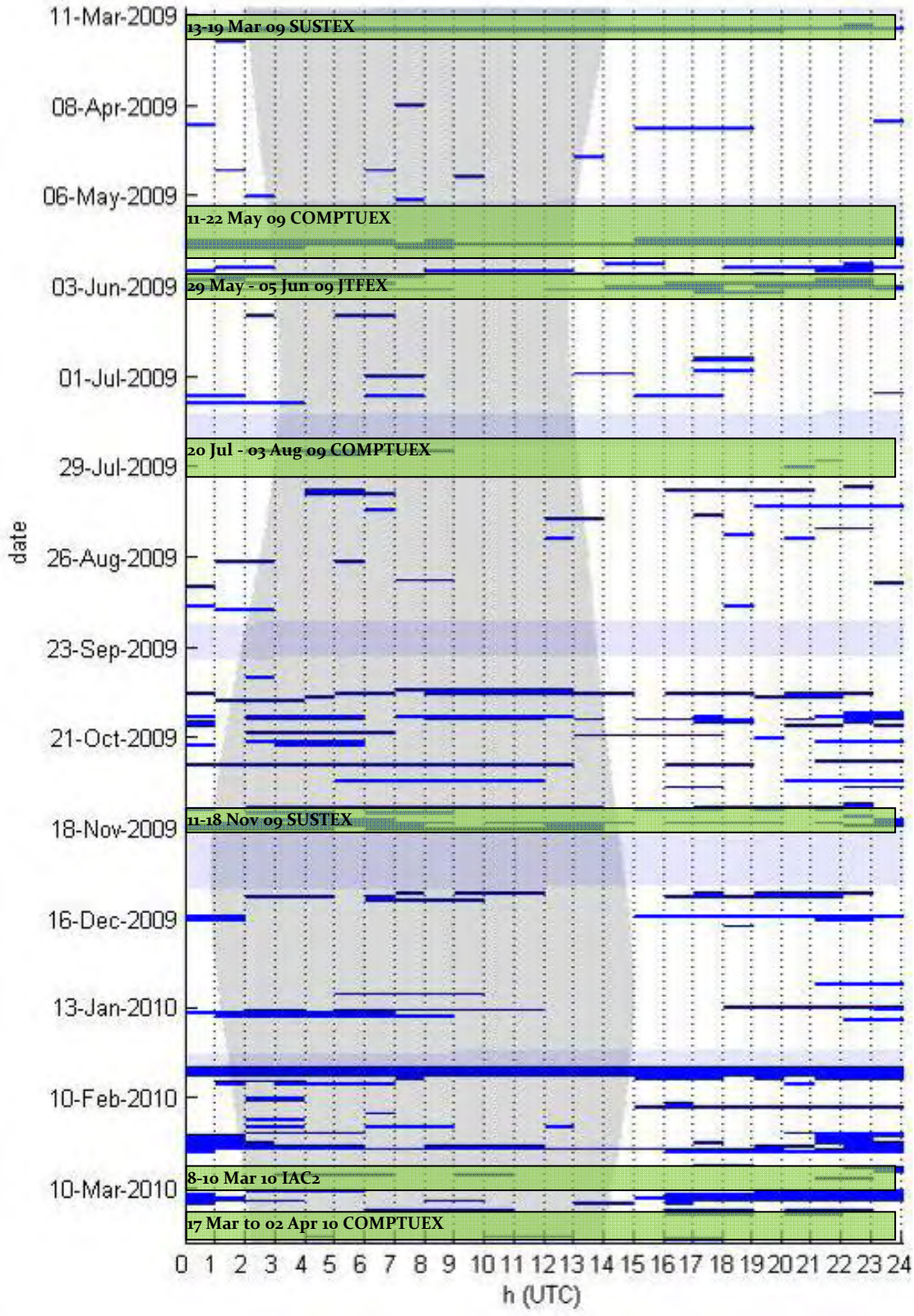
Pacific White-sided Dolphin – All Echolocation Clicks in One-Minute Bins



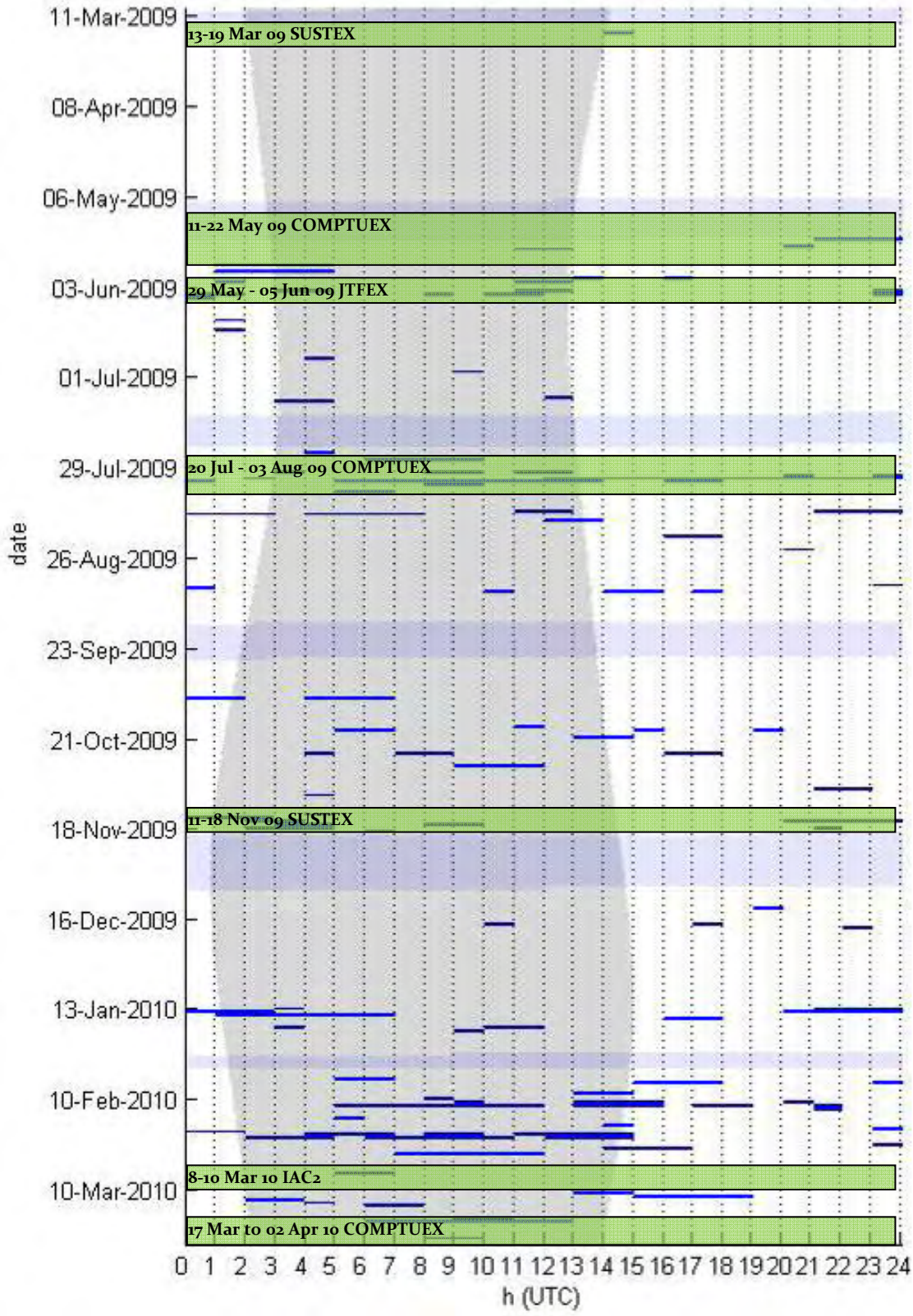
Pinniped - All Call Types in One-Minute Bins



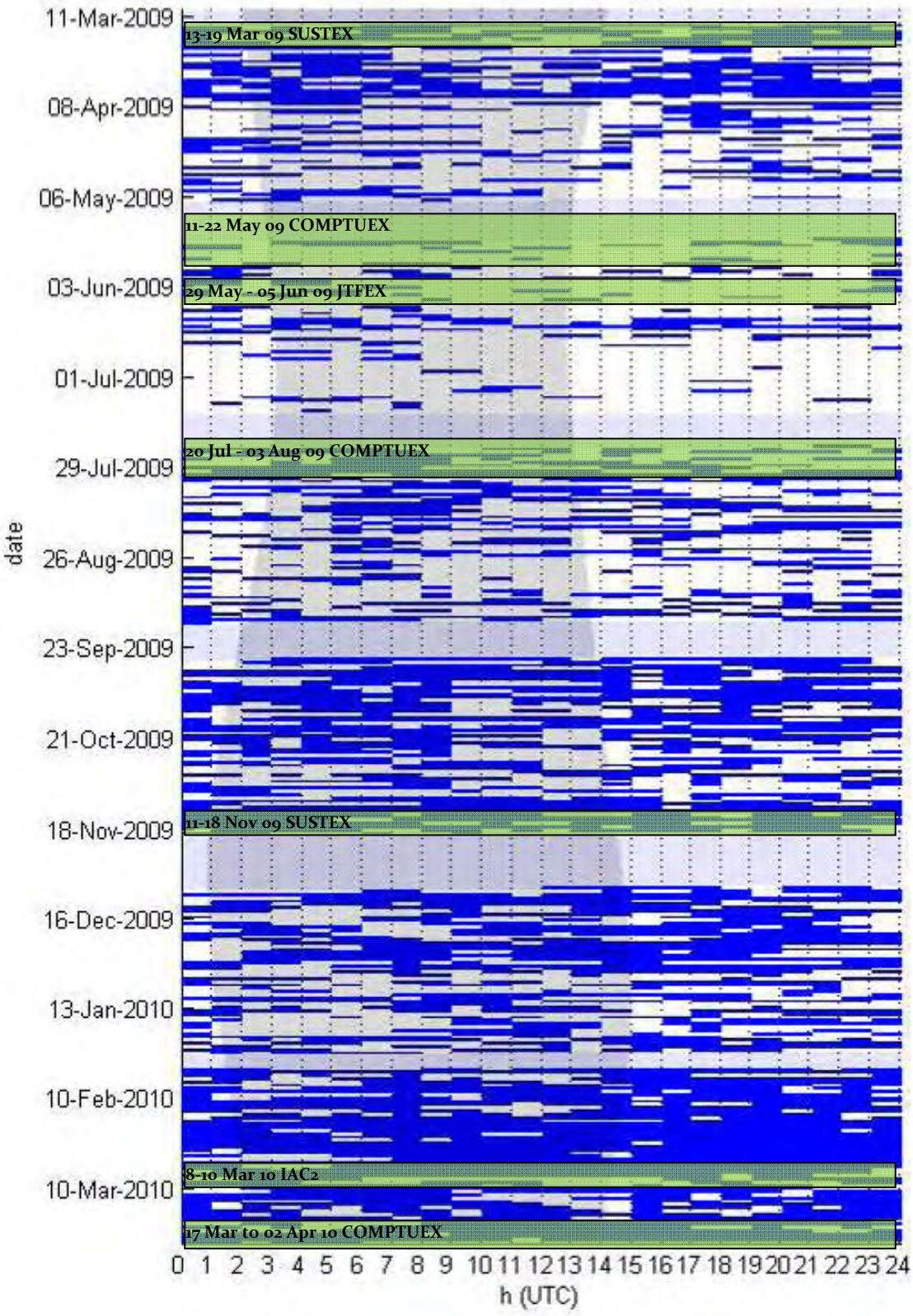
Anthropogenic - All Sound Sources in Hourly Bins



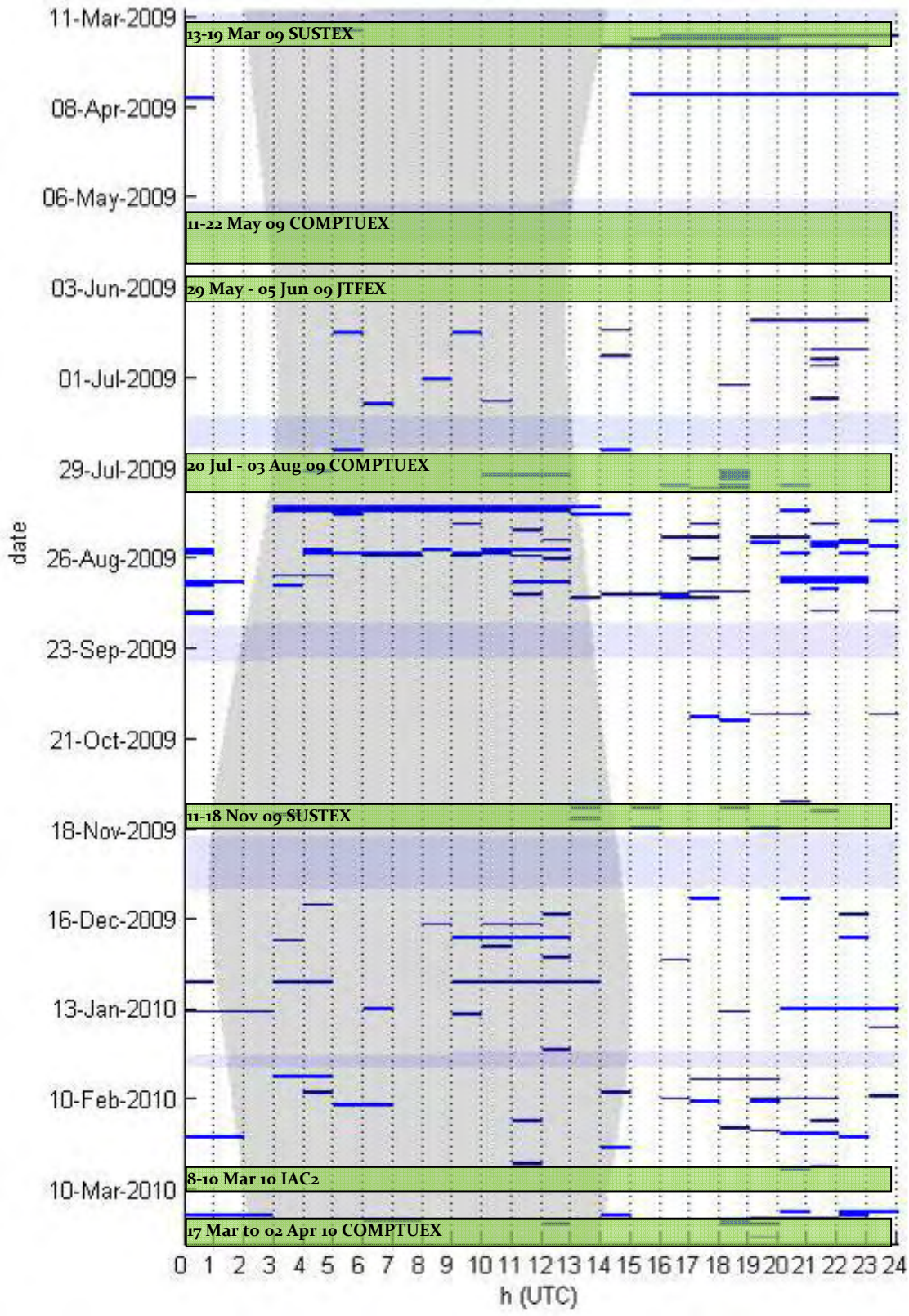
Anthropogenic –Mid-Frequency Active Sonar in Hourly Bins



Anthropogenic - Echosounder, Various Frequencies, in Hourly Bins



Anthropogenic - Ship Engine in Hourly Bins



Anthropogenic - Explosion in Hourly Bin

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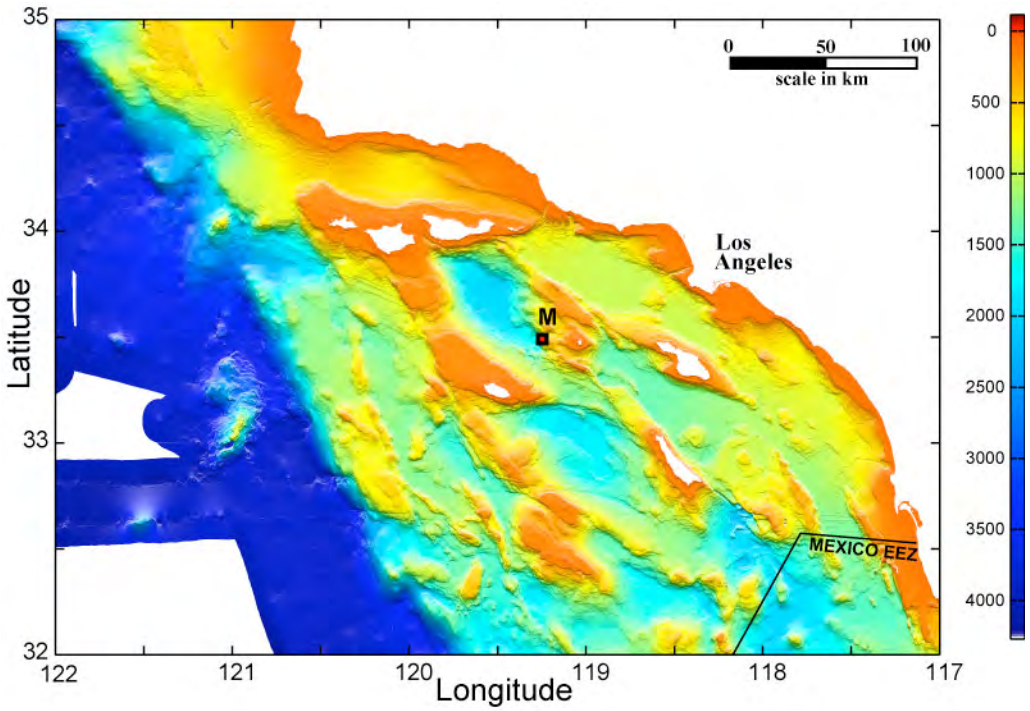

SOCAL Site M

John Hildebrand, Hannah Bassett, Simone Baumann, Greg Campbell, Amanda Cummins, Sara Kerosky, Mariana Melcon, Karlina Merkens, Lisa Munger, Marie Roch, Lauren Roche, Anne Simonis and Sean Wiggins

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Contract Number: FISC N00244-08-1-0028 and FISC N00244-10-C-0021
Project Title: Southern California Marine Mammal Studies
Location: Site M, Latitude 33°31N, Longitude 119°15 W, approx. Depth 1000 m
Deployment Cruises: SOCAL 32 - 37, R/V Sproul
Recording Period: March 11, 2009 – March 25, 2010
Sample Rate: 200kHz Recording Interval: Continuous

Summary

This report summarizes the underwater sounds detected during a series of deployments of a High Frequency Acoustic Recording Package (HARP) in the southern California (SOCAL) offshore region. The HARP records broadband (10 Hz – 100 kHz) acoustic data, including both marine animal and anthropogenic sound. This report summarizes initial analysis to detect the presence of marine mammals by species as well as the occurrence of naval sonar and other anthropogenic sound events.

The HARP deployments were conducted at site M, which is located to the west of Santa Barbara Island and north of the primary area of naval training activity near San Clemente Island. The HARP at site M was deployed and recovered by the R/V Sproul during cruises SOCAL 32 (March 11, 2009) through SOCAL 38 (April 9, 2010). It recorded acoustic data continuously at a 200 kHz sample rate with data gaps in-between deployments, resulting in a total of 320 days (7591 hours) of recording over a period of 379 days. Table 1 provides a summary of HARP deployment dates, locations, and recording times.

We investigated the temporal occurrence of marine mammal and anthropogenic sound using manual analysis of three frequency bands: 10-1000 Hz (Low); 1000-5000 Hz (Mid); and 5-100 kHz (High). For each of these bands one or more analysts scanned the data using a long-term spectrogram display with approximately one hour of data per display. A MATLAB based software package called *TRITON* was used for data display and event logging. Potential sound events detected in a one-hour or shorter spectrogram were investigated at finer temporal scales to identify the origin of the sound by species or type of anthropogenic sound. Table 2 gives a summary, by species-call type or anthropogenic sound source, of the number of hours and days which sounds were detected, as well as the percentage of hours or days they were detected.

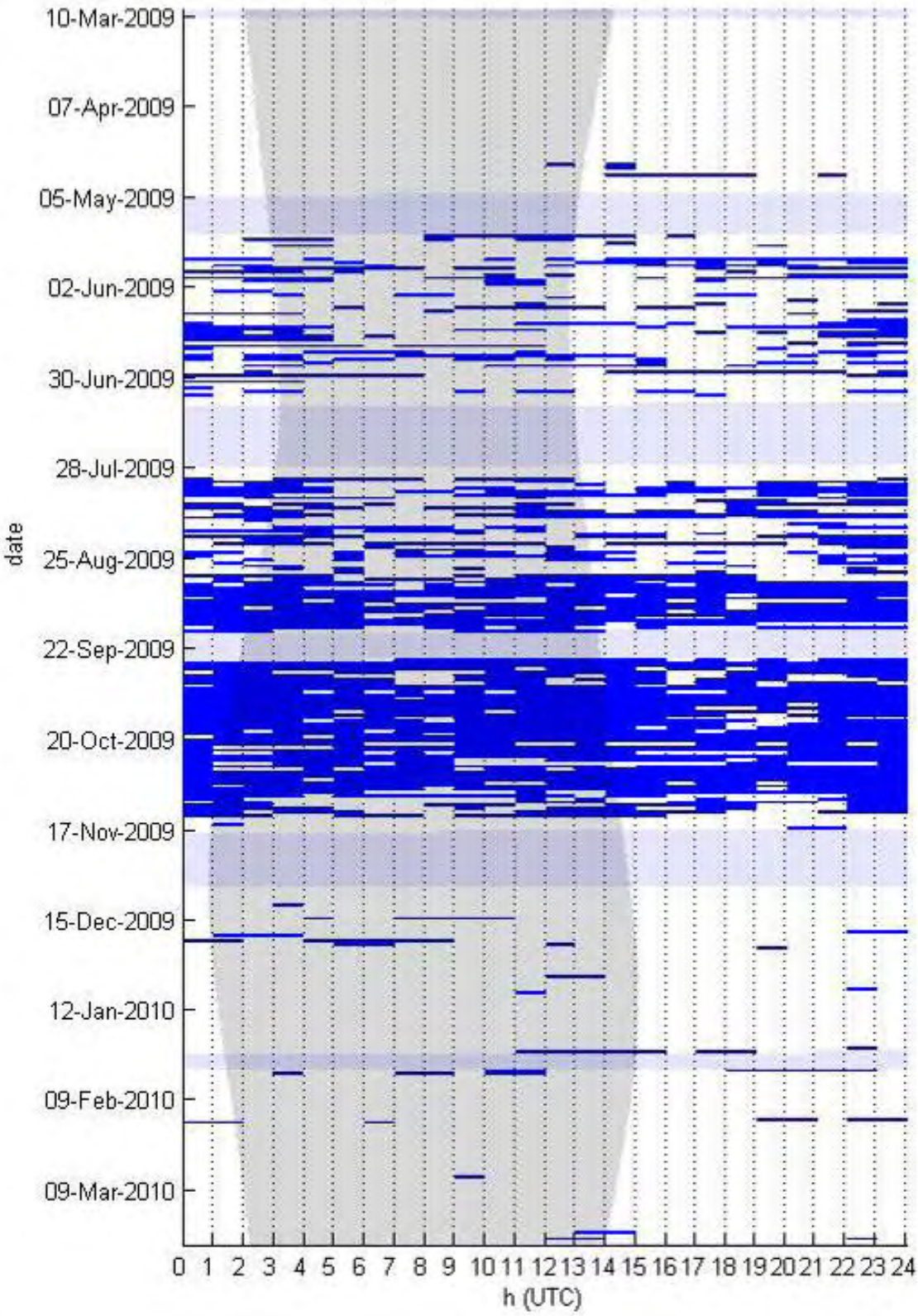
The detections for each call type or anthropogenic sound are also presented as a series of plots below. Sound detections are represented as a solid bar in hourly or minute bins, with each day of data along a horizontal line. Nighttime is indicated in a darker transparent color, and periods of off-effort (no acoustic data) are shown in light blue. Detected marine mammals include: blue whale, fin whale, unidentified whale, Bryde's whale, minke whale, humpback whale, sperm whale, killer whale, unidentified beaked whale, Baird's beaked whale, Risso's dolphin, Pacific white-sided dolphin, unidentified odontocete, and pinniped. Anthropogenic sounds include mid-frequency active sonar, echosounder, ship noise and explosion.

Table 1. HARP Deployment Dates, Locations and Recording Times.

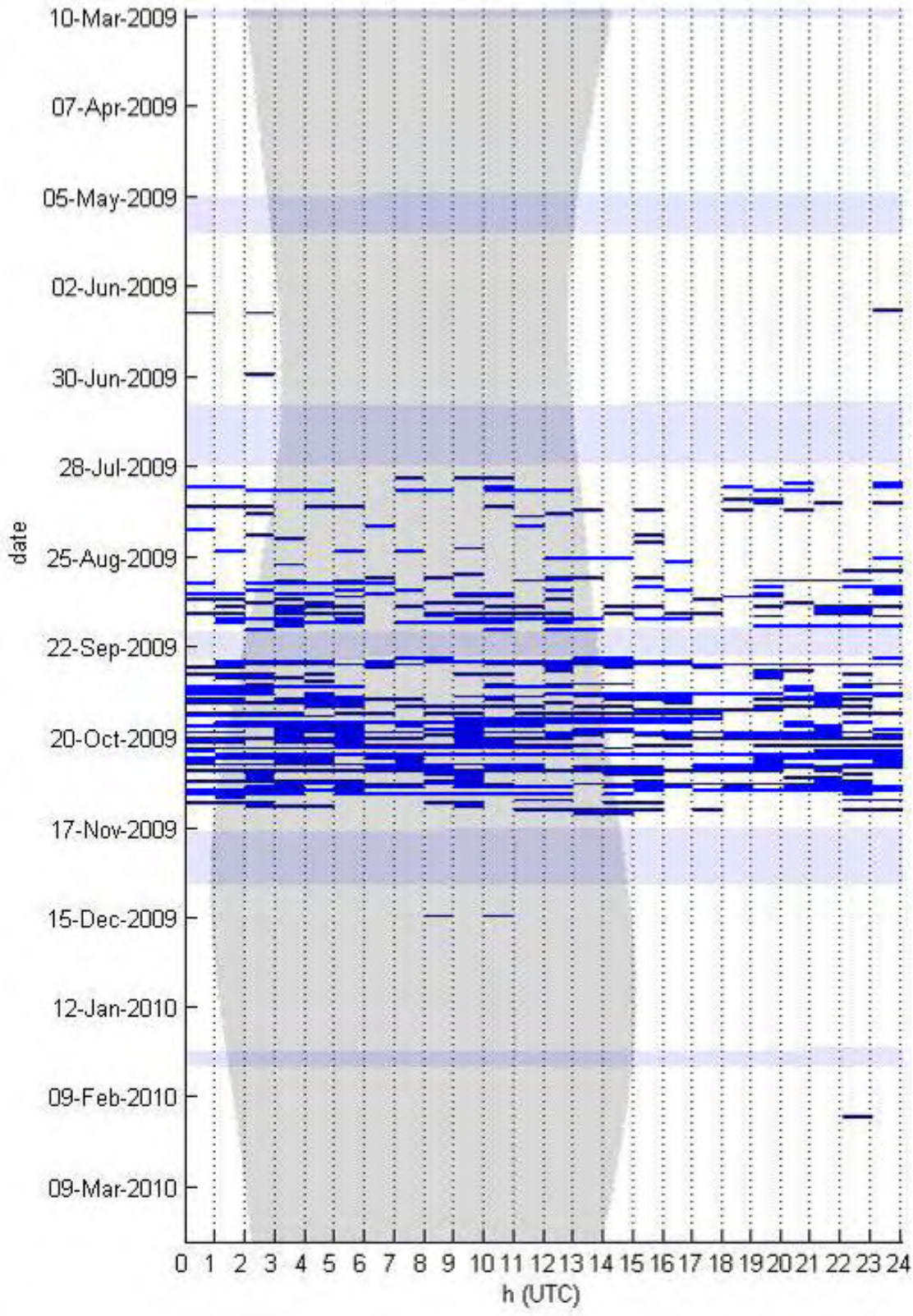
Site/Cruise	Deployment Date	Recovery Date	Deployment Latitude N	Deployment Longitude W	Depth (m)	Recording Start	Recording End	Days	Hours
SOCAL32M	3/10/2009	5/16/2009	33-30.579	119-15.280	1123	3/11/2009	5/4/2009	55	1303
SOCAL33M	5/16/2009	7/26/2009	33-30.580	119-15.253	1120	5/17/2009	7/8/2009	53	1263
SOCAL34M	7/27/2009	9/25/2009	33-30.927	119-14.794	902	7/27/2009	9/16/2009	52	1226
SOCAL35M	9/25/2009	12/4/2009	33-30.923	119-14.779	912	9/25/2009	11/17/2009	54	1275
SOCAL36M	12/4/2009	1/29/2010	33-30.937	119-14.798	912	12/5/2009	1/24/2010	51	1221
SOCAL37M	1/29/2010	4/9/2010	33-30.915	119-14.960	891	1/30/2010	3/25/2010	55	1303

Table 2. Detections of Marine Mammal Species and Anthropogenic Sound Sources.

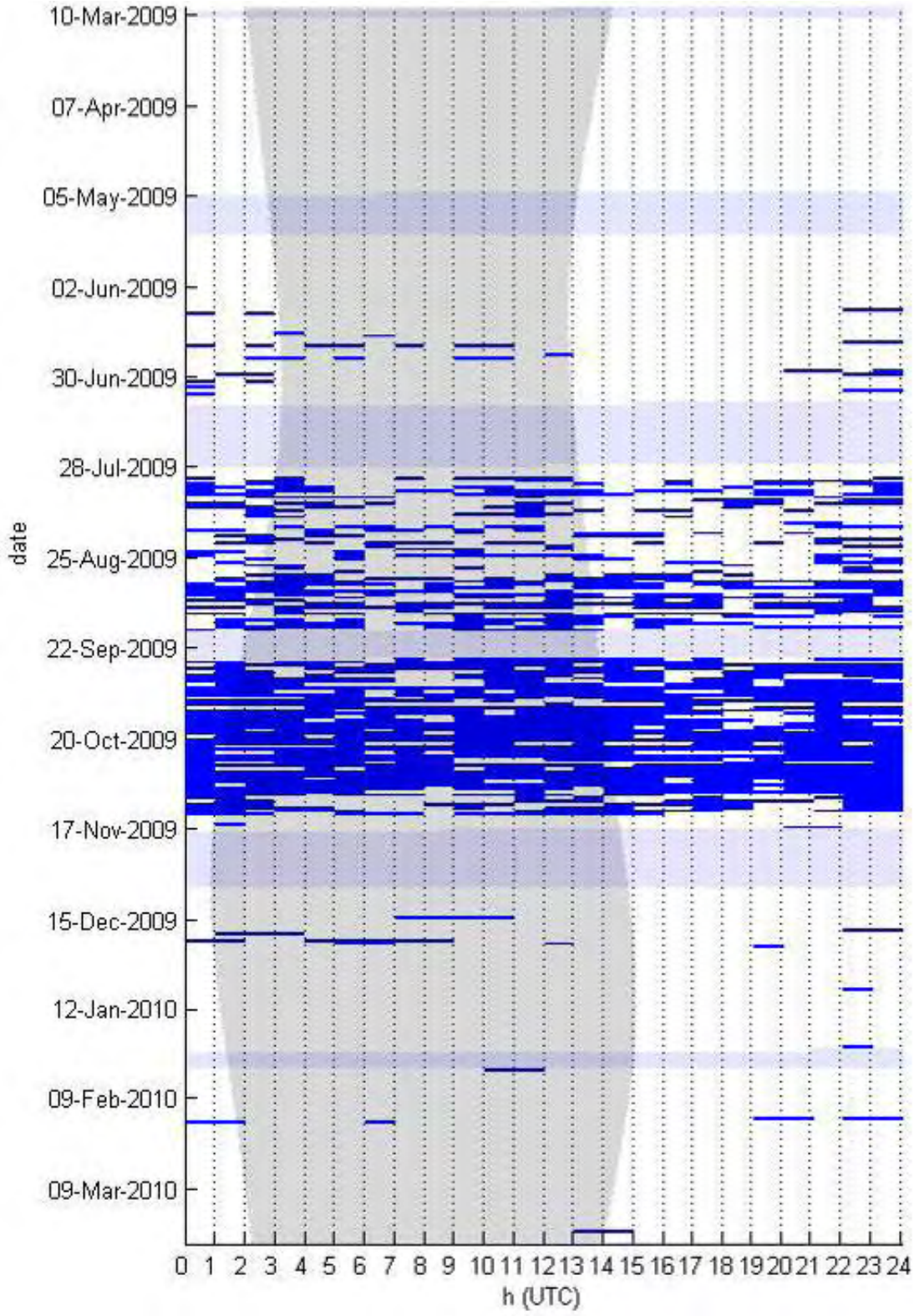
Species/Source	Call Type	Hour Bins	Percent Hours	Daily Bins	Percent Days
Blue Whale	All	967	13	112	35
Blue Whale	A	182	2	44	14
Blue Whale	B	507	7	73	23
Blue Whale	D	368	5	76	24
Blue Whale	Song	171	2	34	11
Fin Whale	All	4263	56	266	83
Unidentified Whale	50 Hz	1175	15	197	62
Bryde's Whale	All	182	2	29	9
Minke Whale	All	22	0.3	7	2
Humpback Whale	All	1192	16	184	58
Humpback Whale	Song	804	11	90	28
Odontocete	Clicks	4859	64	320	100
Sperm Whale	Clicks	76	1	25	8
Killer Whale	Whistles/ Clicks	29	0.4	12	4
Unidentified Odontocete	Low-Freq. Whistles/ Clicks	15	0.2	9	3
Beaked Whale	Clicks	231	3	146	46
Baird's Beaked Whale	Clicks	6	0.1	4	1
Risso's Dolphin	Whistles/ Clicks	460	6	139	43
Pacific White-sided Dolphin	Whistles/ Clicks	208	3	42	13
Pinniped	All	555	7	58	18
Anthropogenic	All	3190	42	290	91
Anthropogenic	Mid-Frequency Active Sonar	258	3	50	16
Anthropogenic	Echosounder Ping	36	0.5	24	8
Anthropogenic	Ship Engine Noise	2543	34	269	84
Anthropogenic	Explosion	504	7	99	31



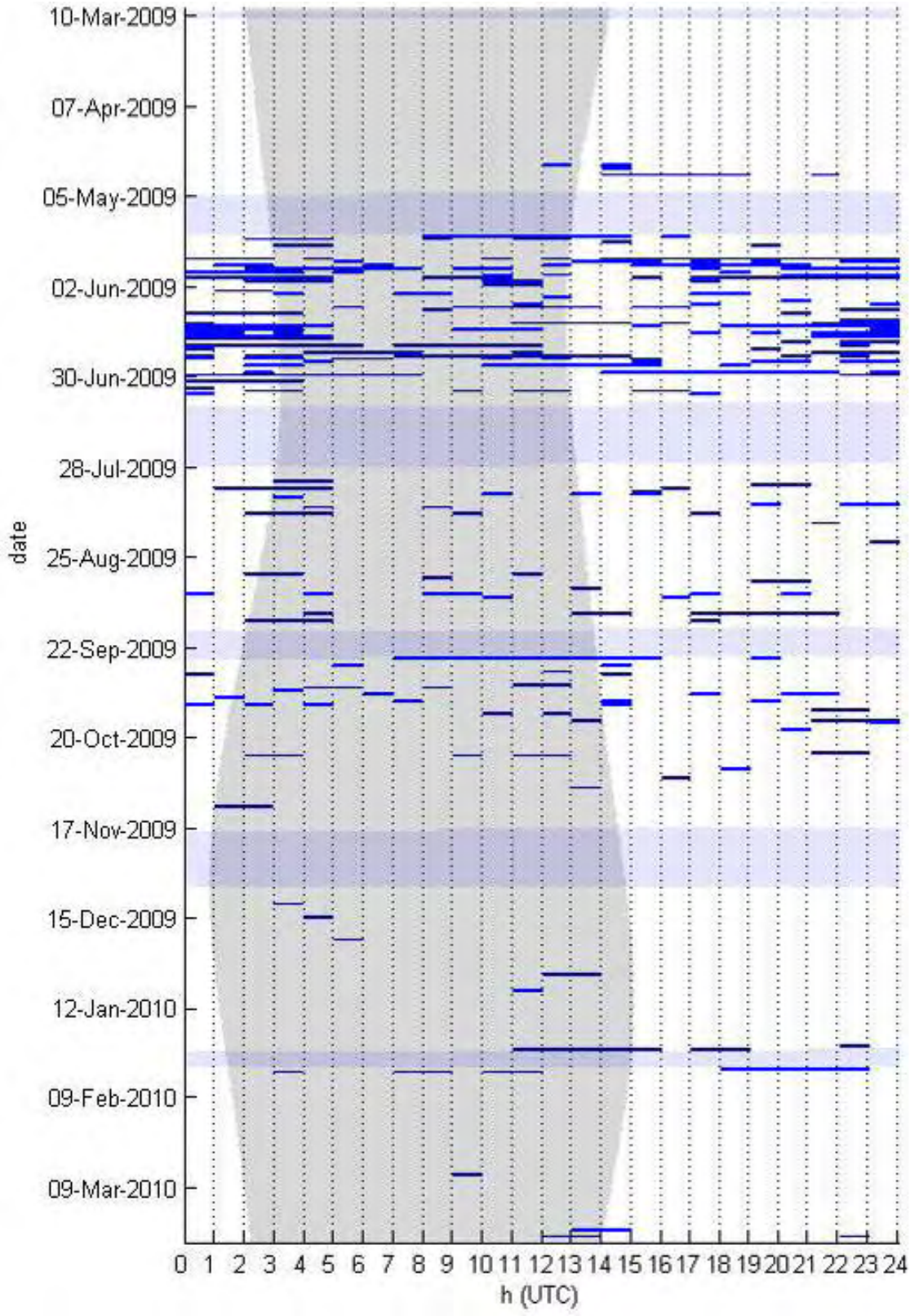
Blue Whale – All Call Types in Hourly Bins



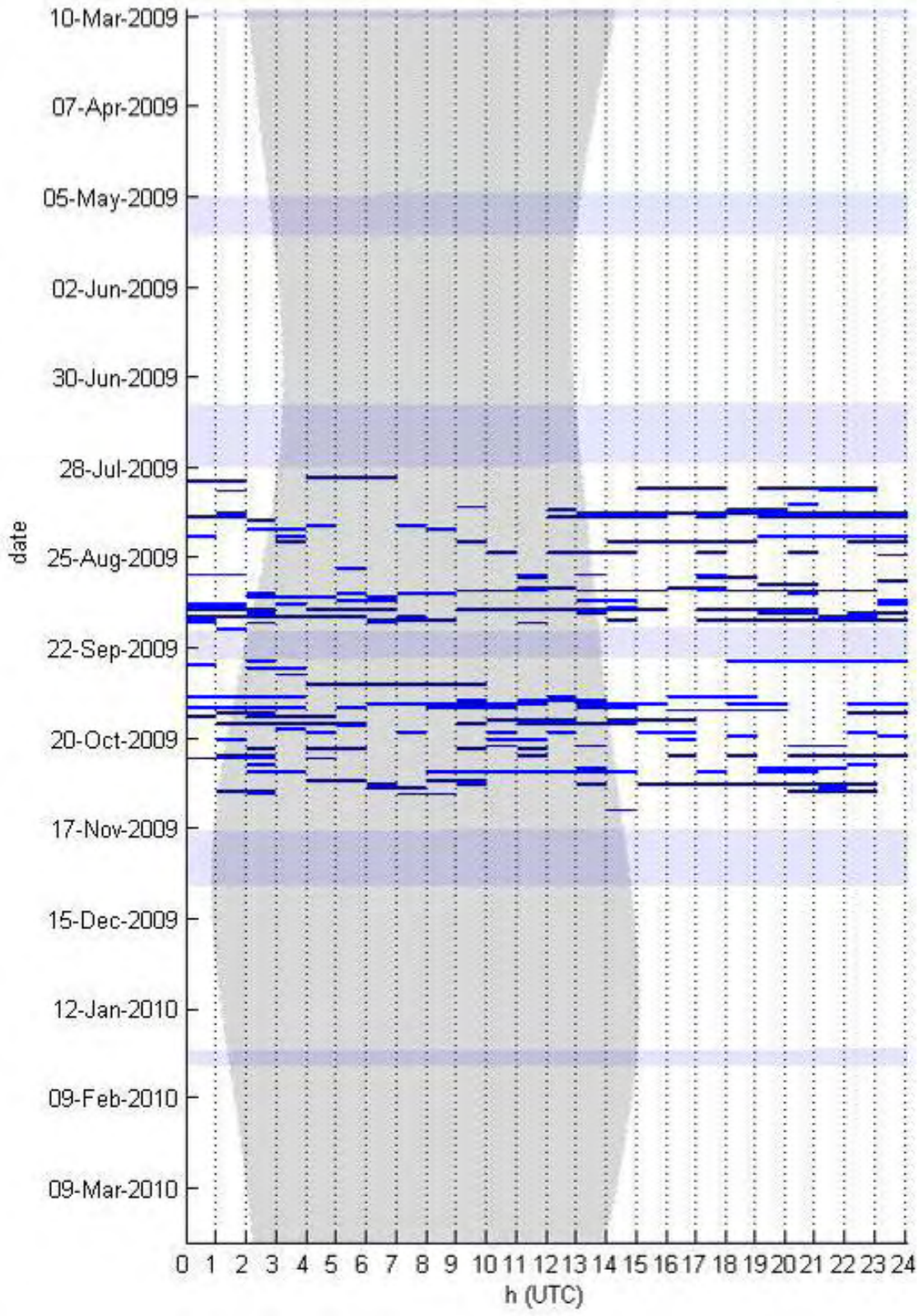
Blue Whale - "A" Call in Hourly Bins



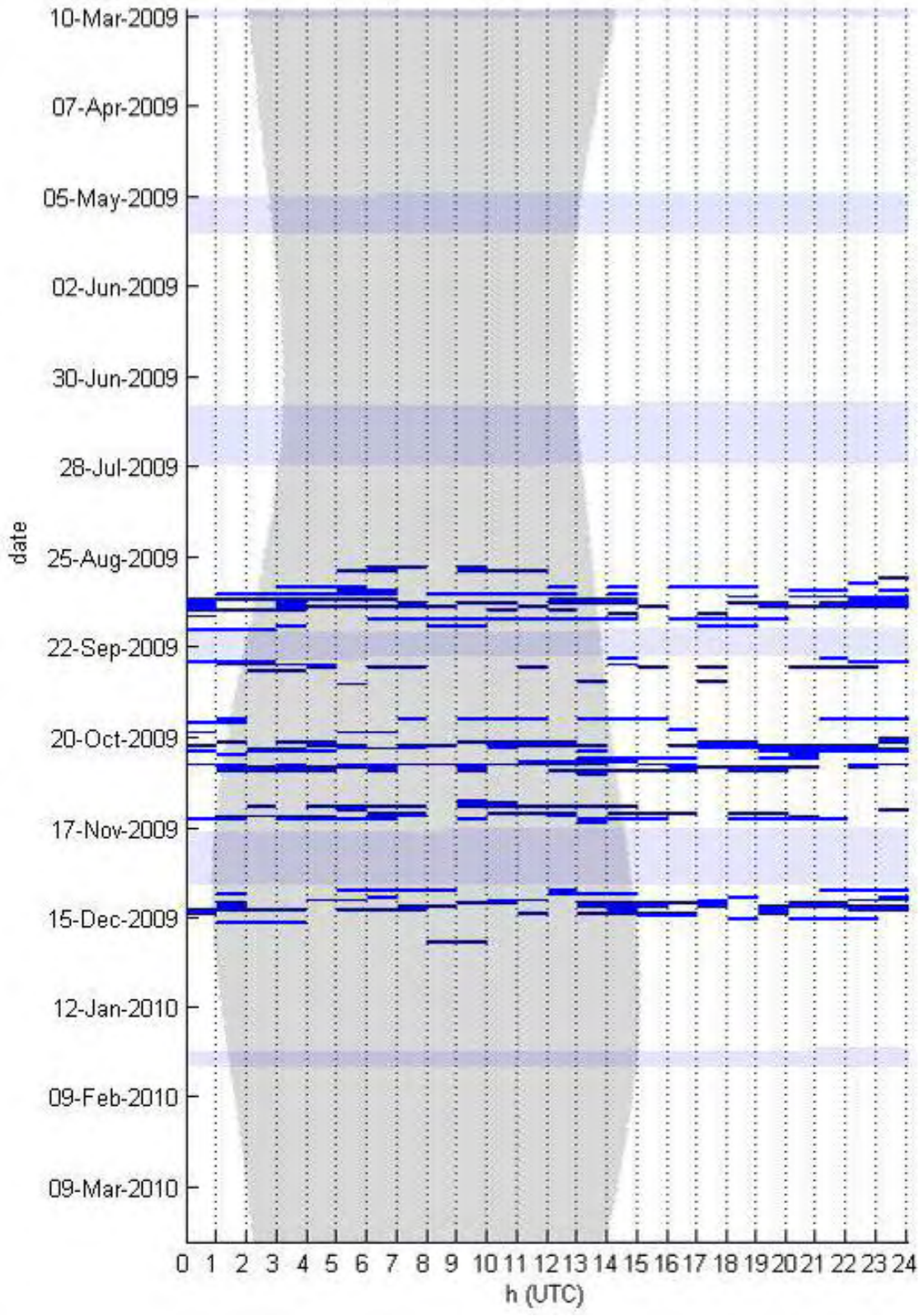
Blue Whale - "B" Call in Hourly Bins



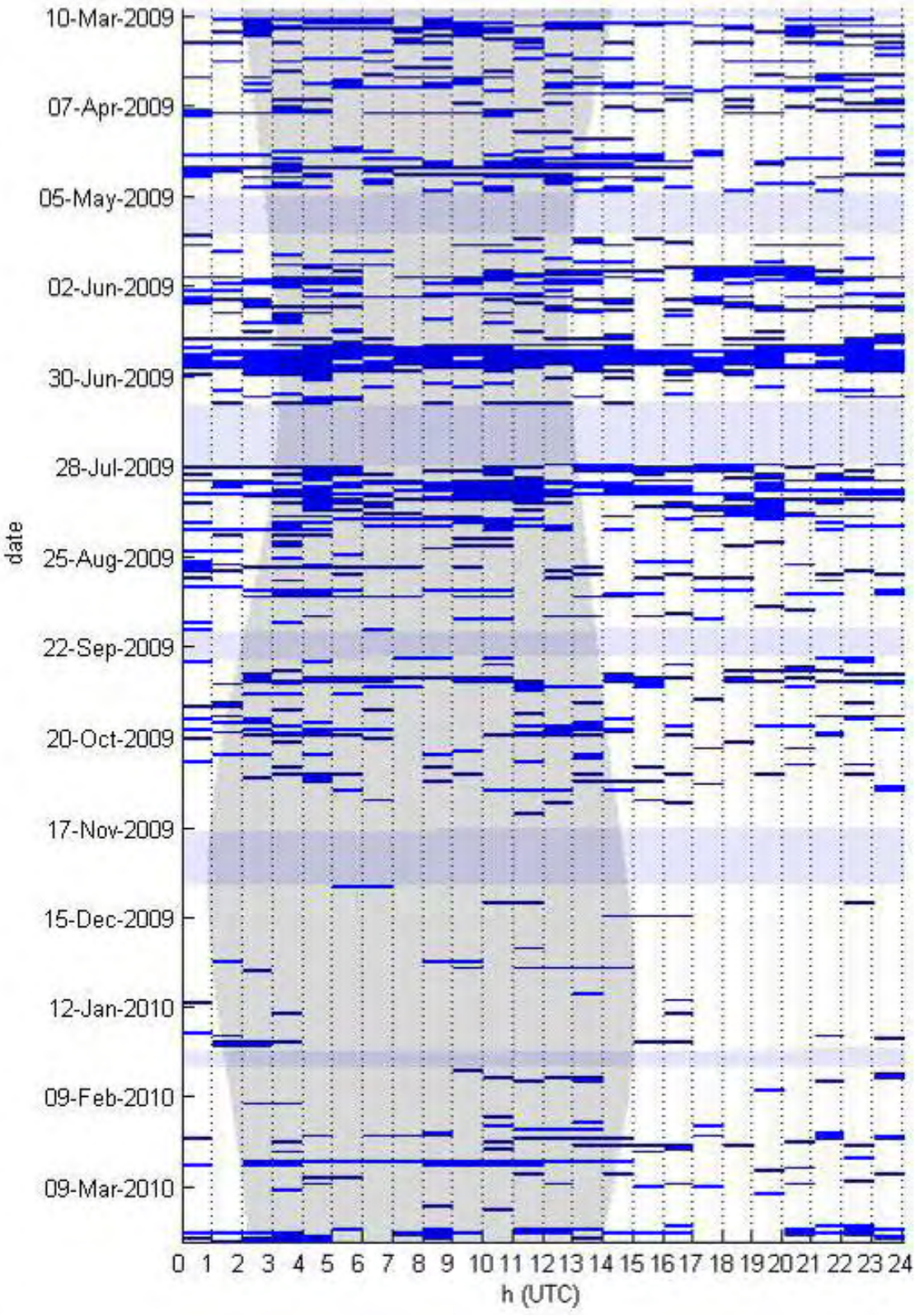
Blue Whale - "D" Call in Hourly Bins



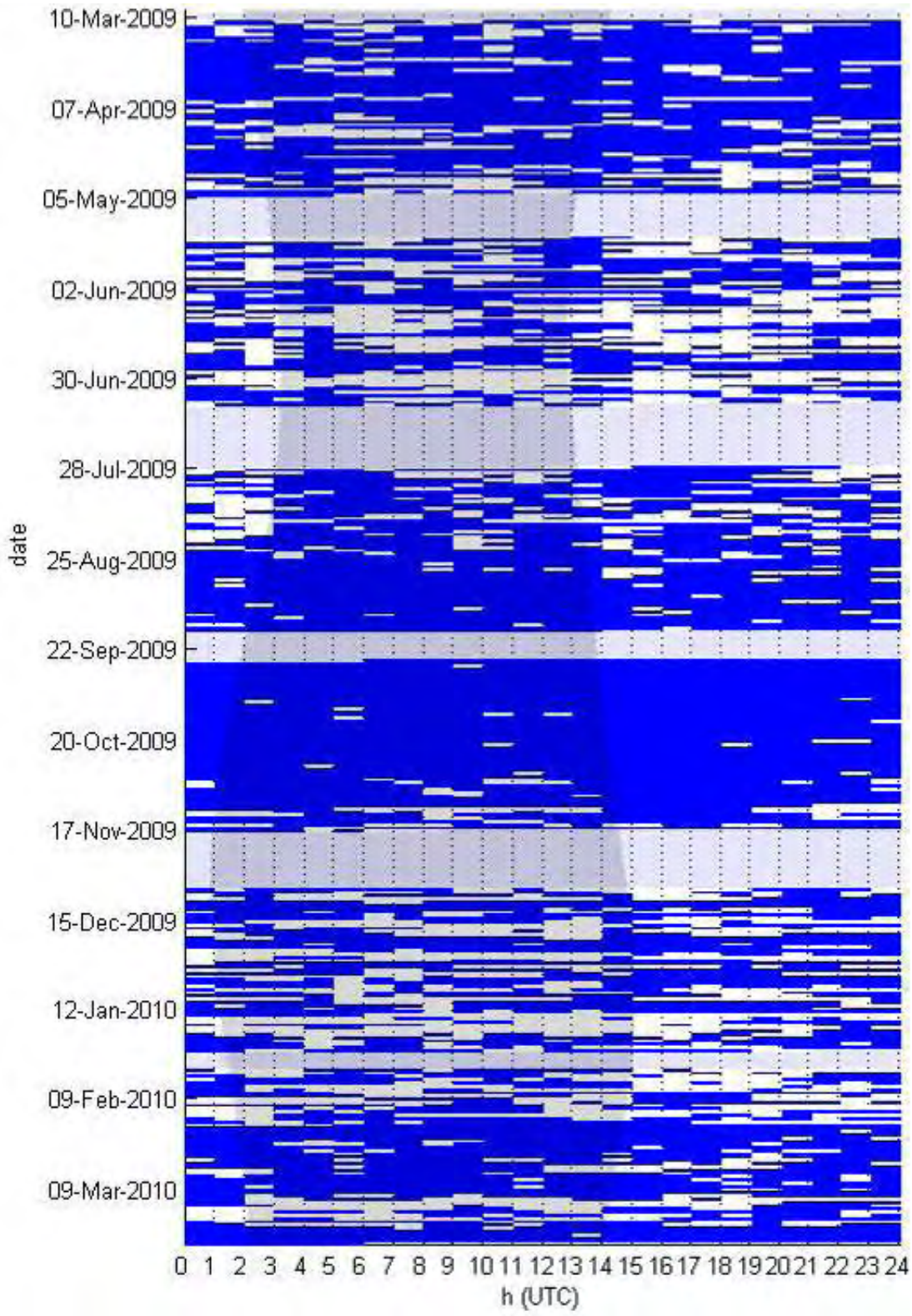
Blue Whale - Song in Hourly Bins



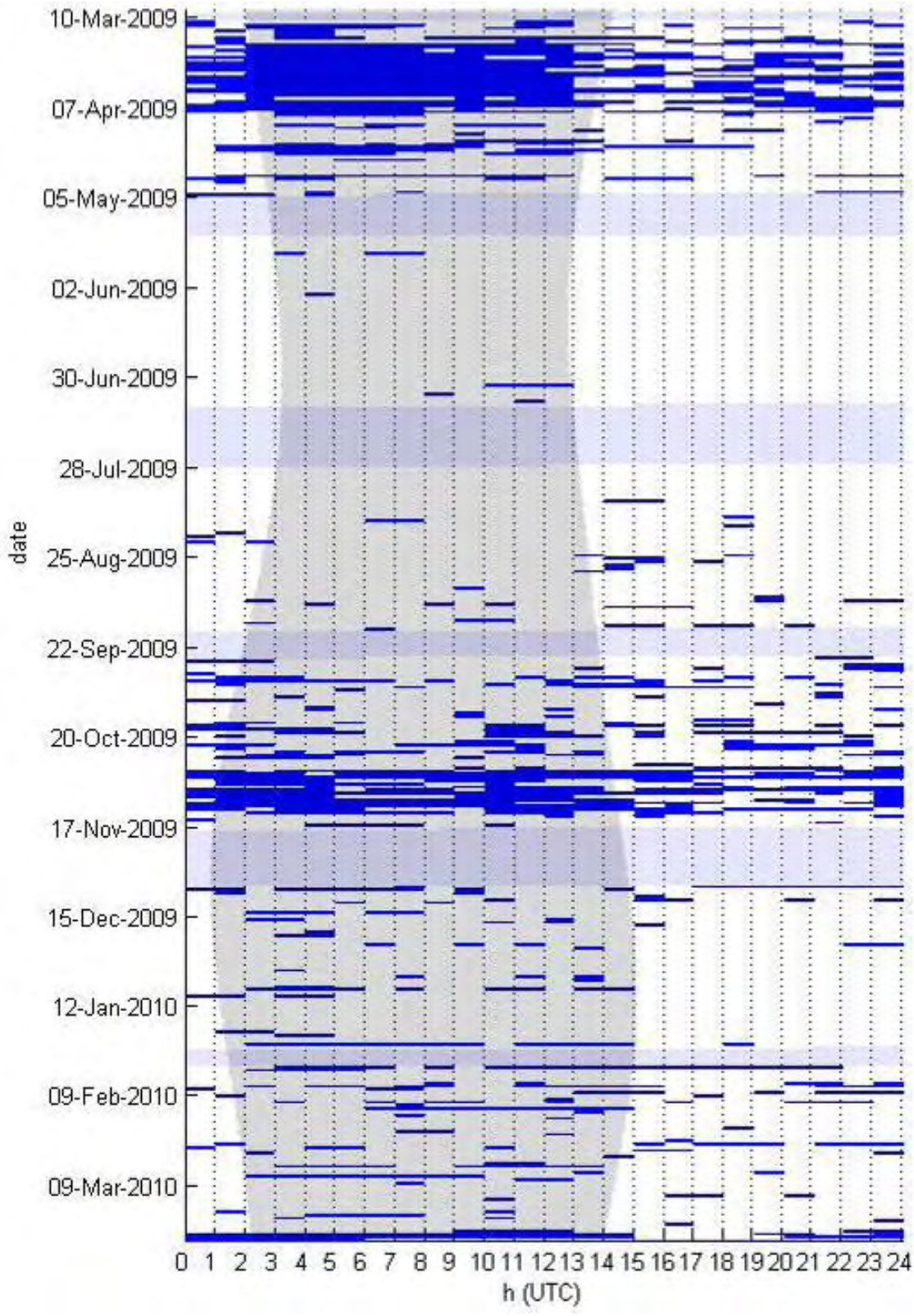
Bryde's Whale – All Call Types in Hourly Bins



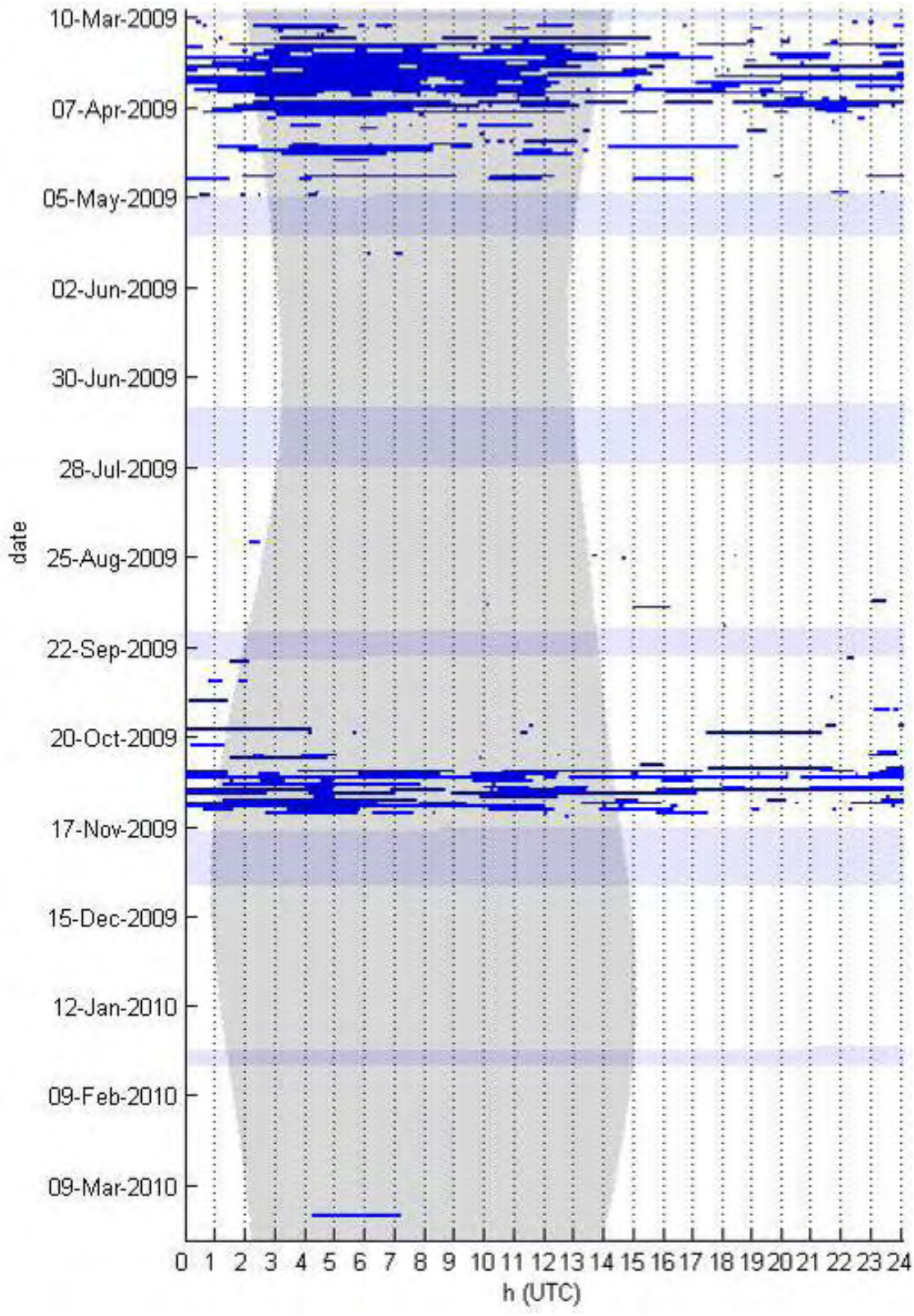
Unidentified Whale - 50 Hz Call in Hourly Bins



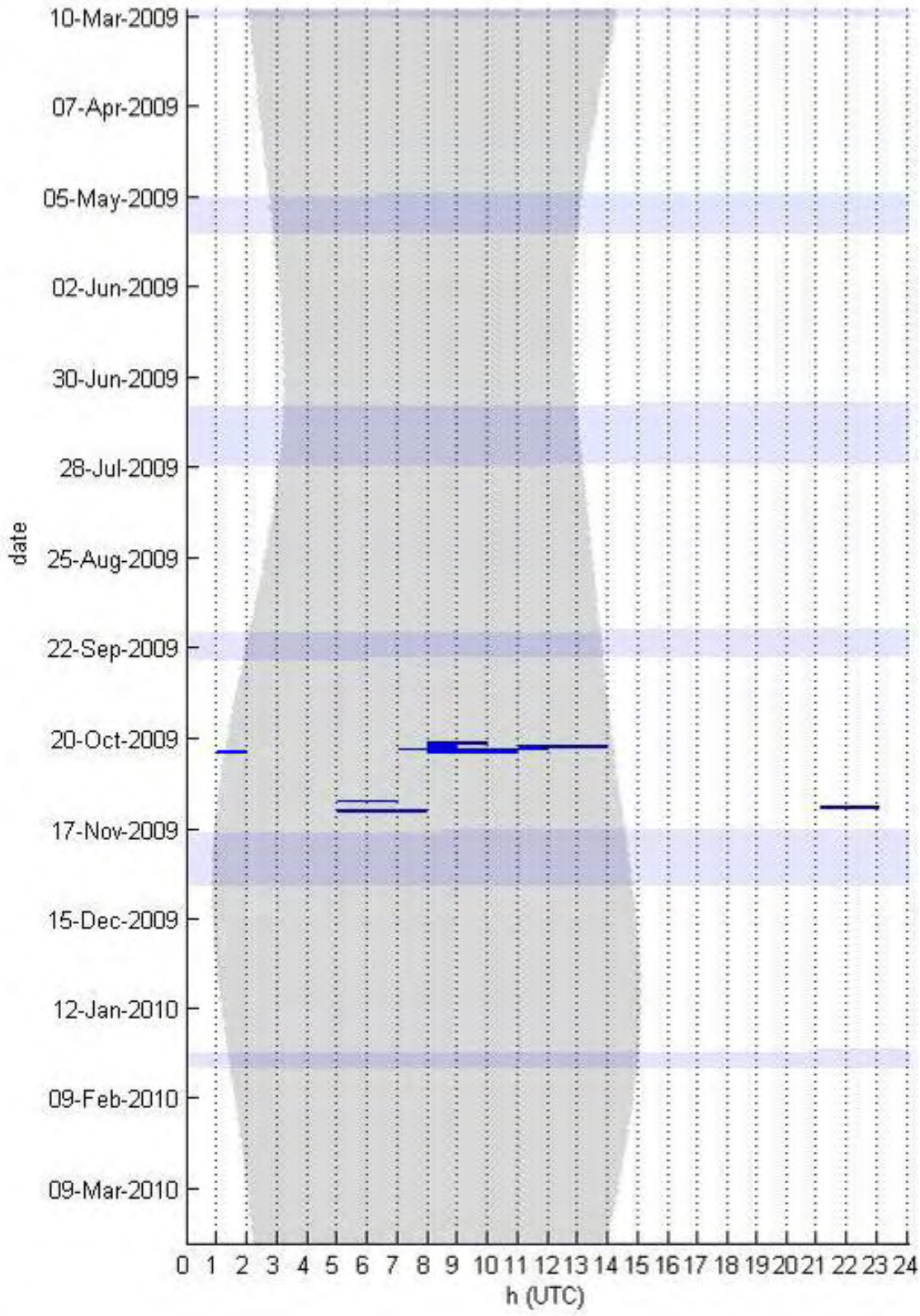
Fin Whale - All Call Types in Hourly Bins



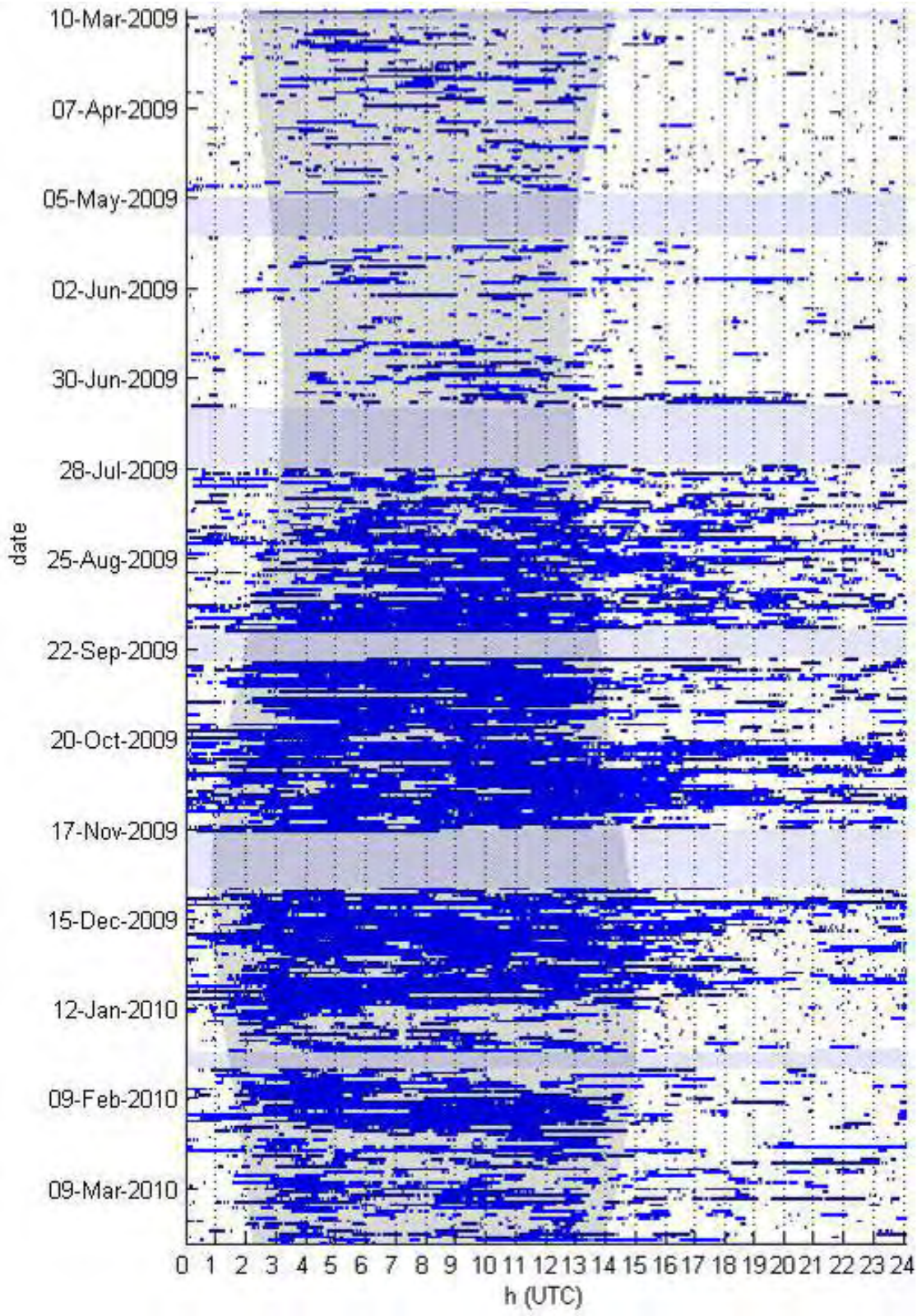
Humpback Whale - All Call Types in Hourly Bins



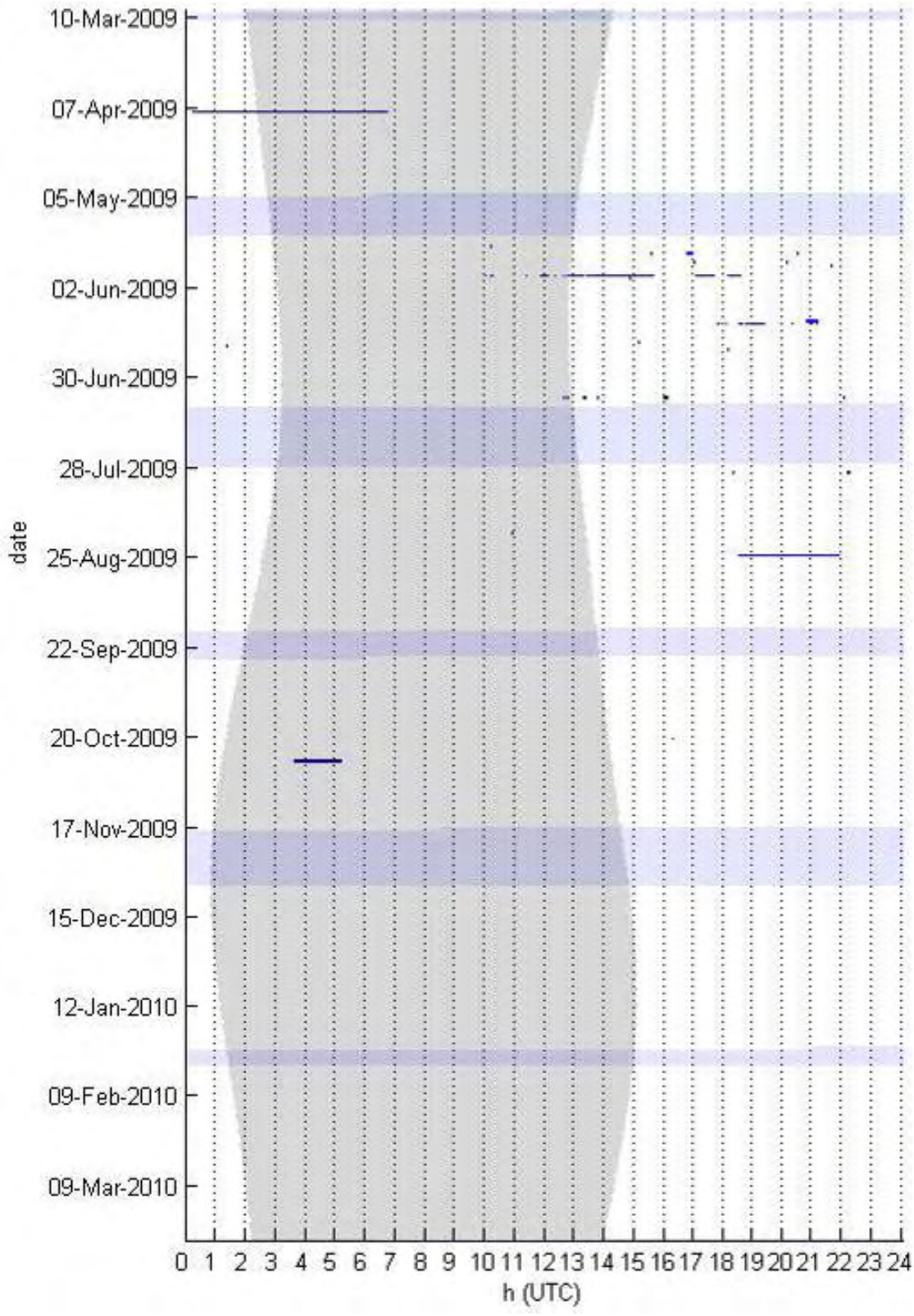
Humpback Whale - Song in One-Minute Bins



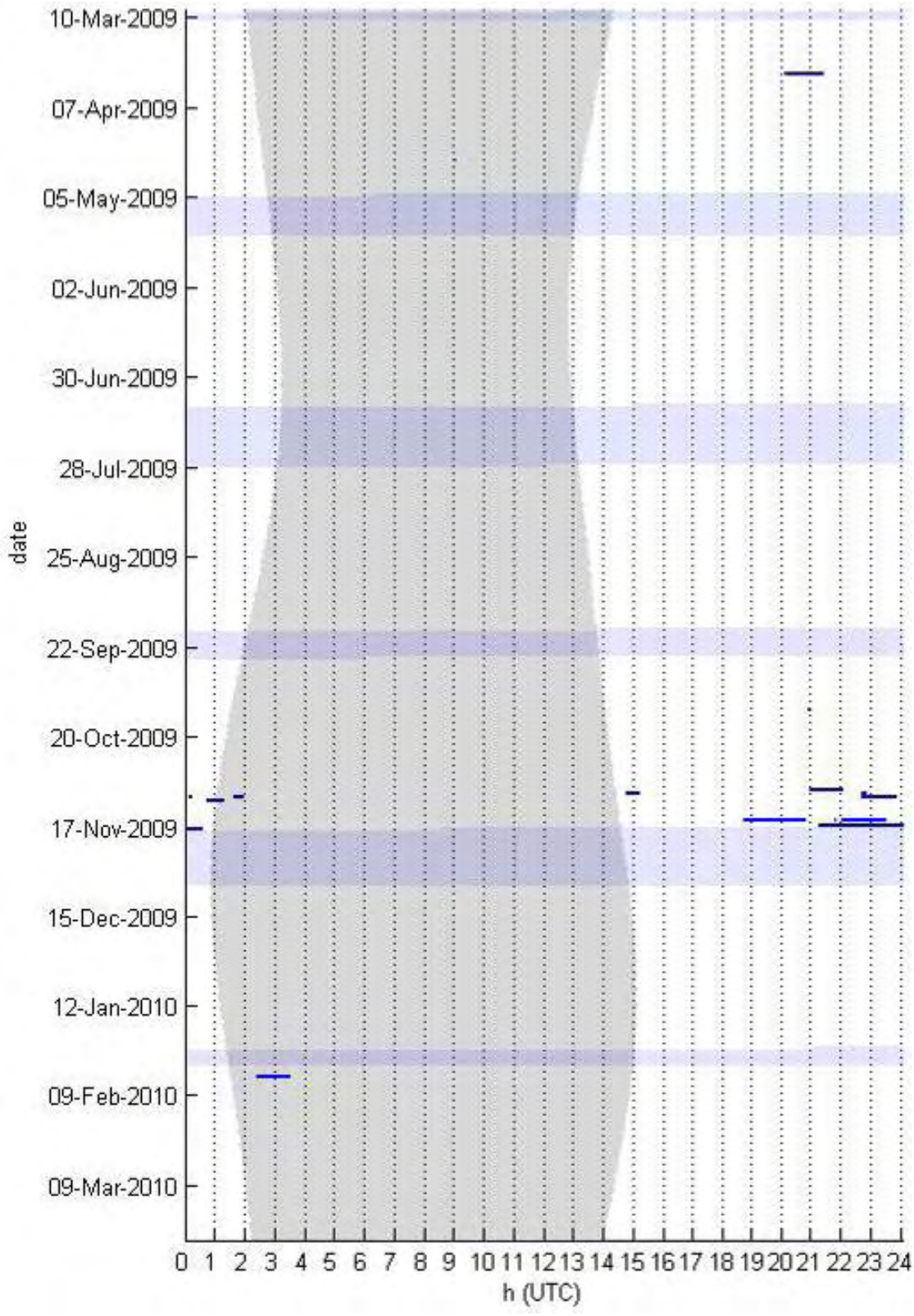
Minke Whale – All Call Types in Hourly Bins



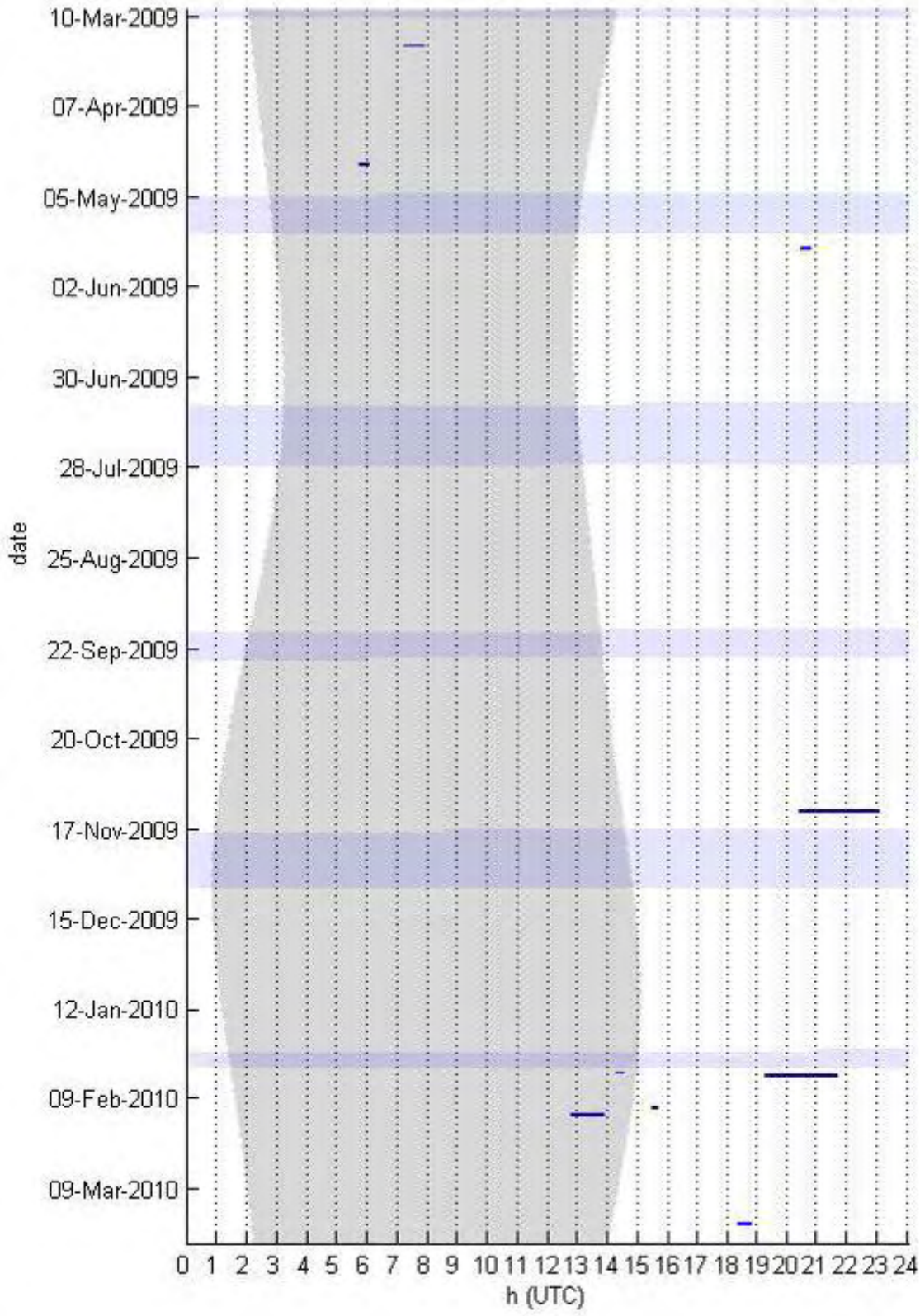
Odontocete - Echolocation Clicks in One-Minute Bins



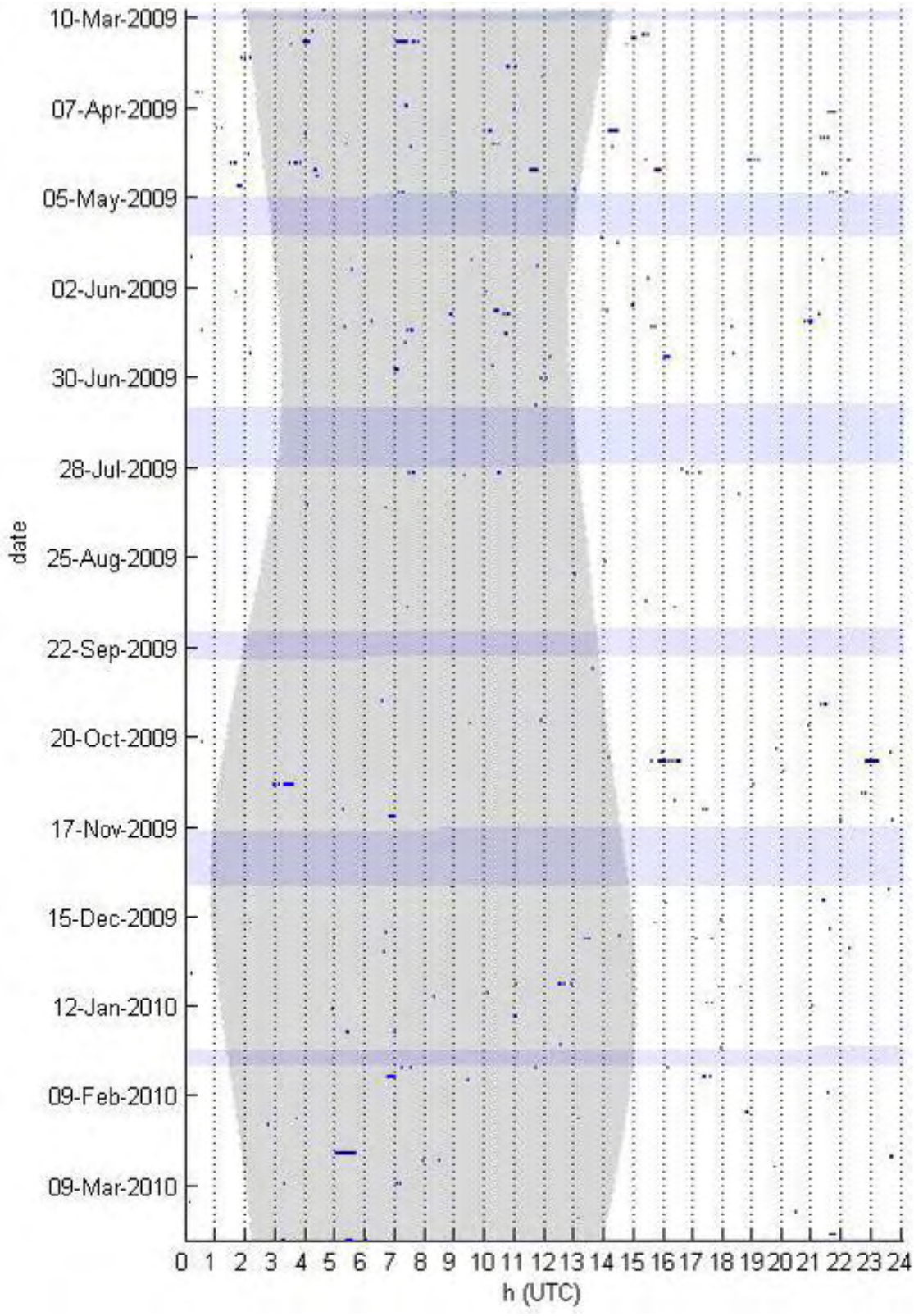
Sperm Whale - Echolocation Clicks in One-Minute Bins



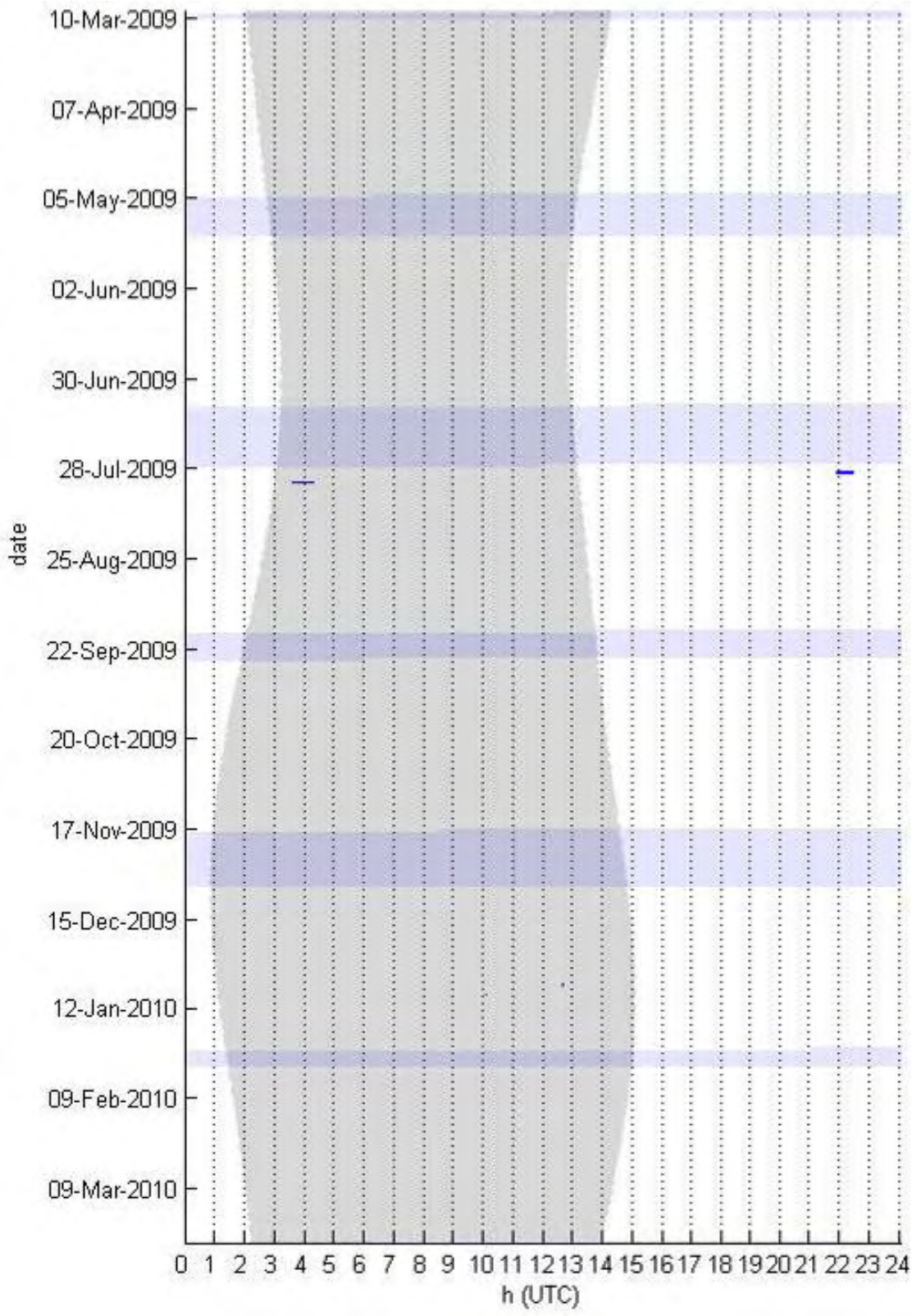
Killer Whale – Whistles and Echolocation Clicks in One-Minute Bins



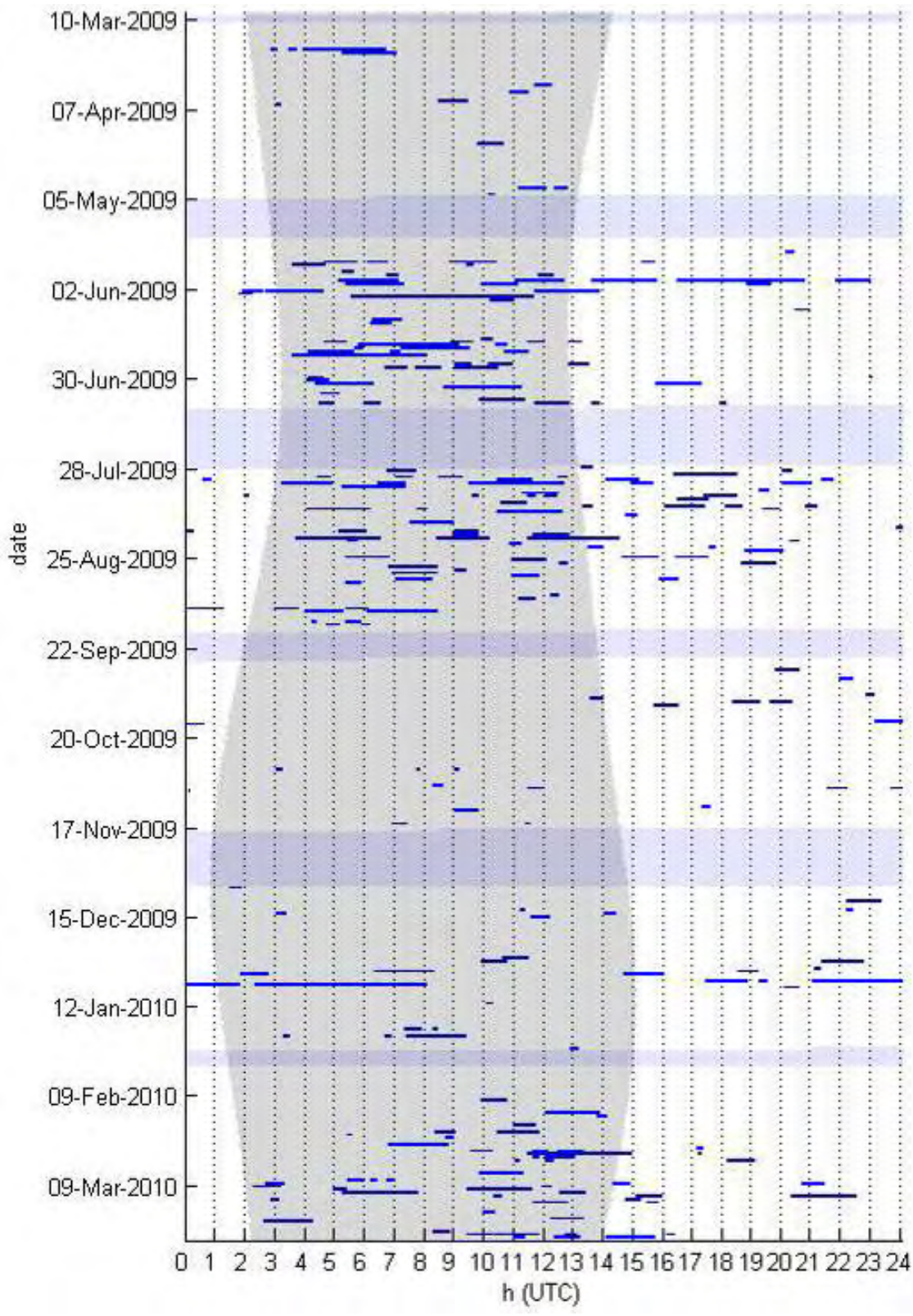
Unidentified Odontocete – Low-Frequency Whistles and Echolocation Clicks in One-Minute Bins



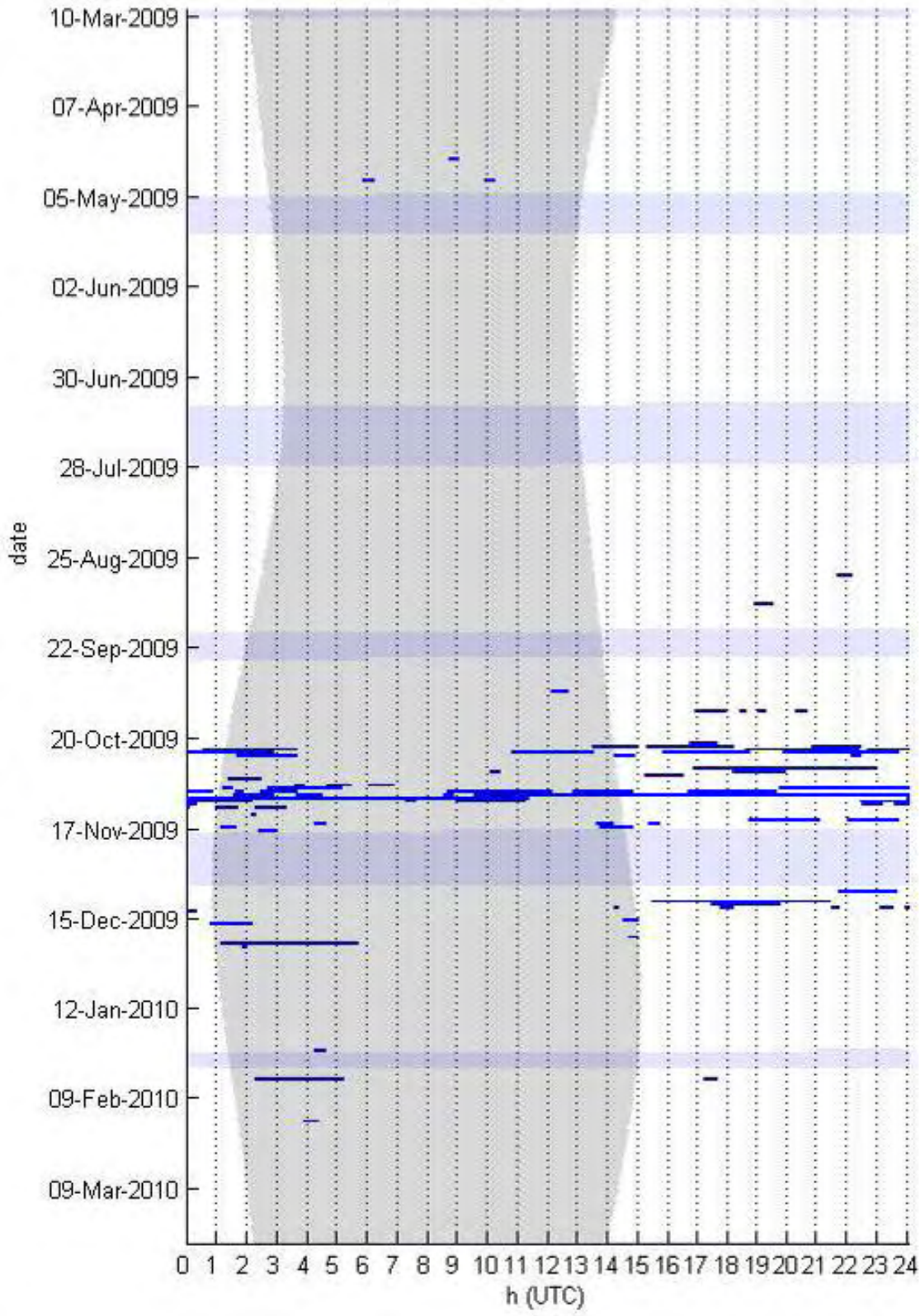
Beaked Whale - Frequency-Modulated Clicks (20 kHz < Peak Frequency < 55 kHz) in One-Minute Bins



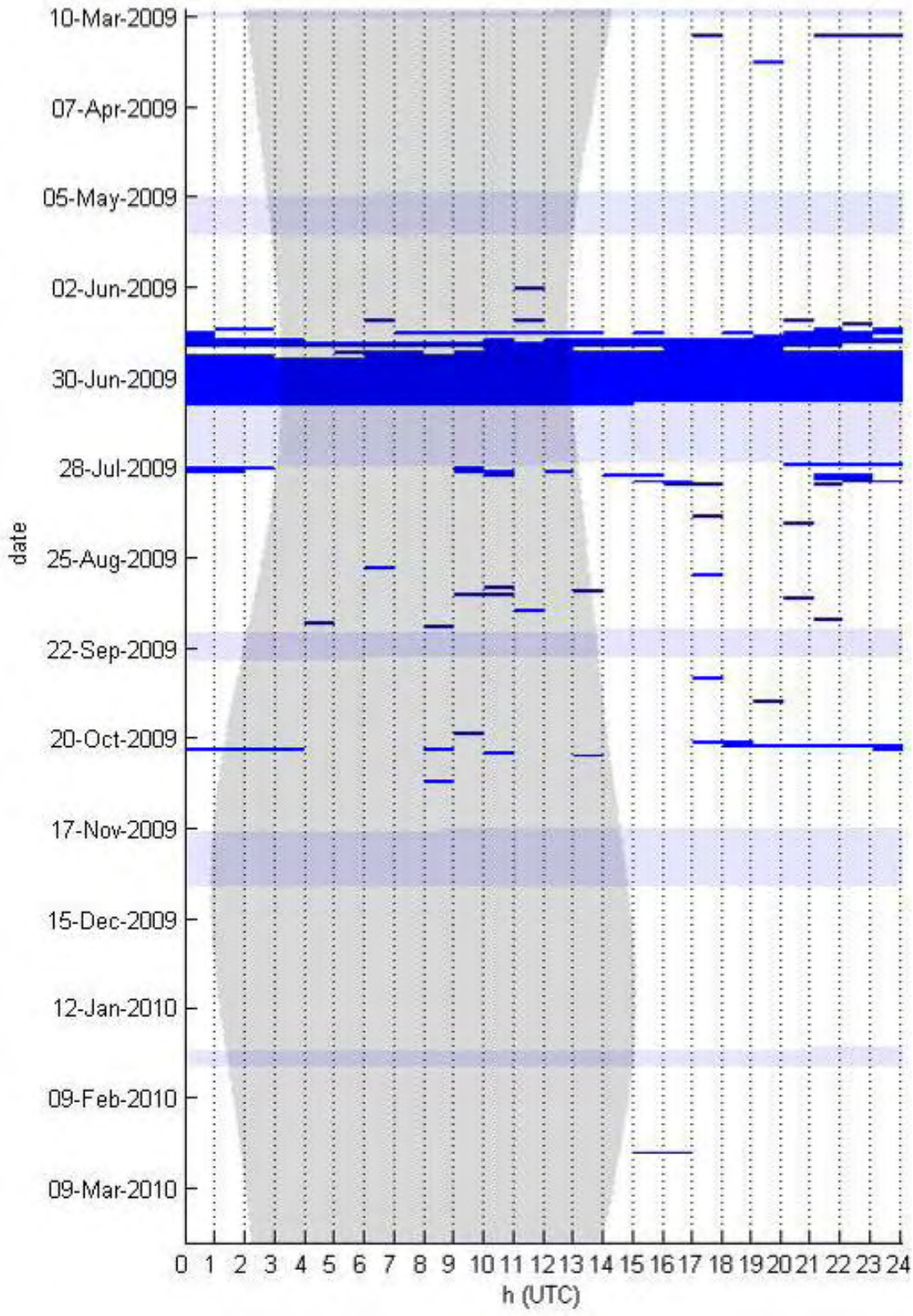
Baird's Beaked Whale – All Call Types in One-Minute Bins



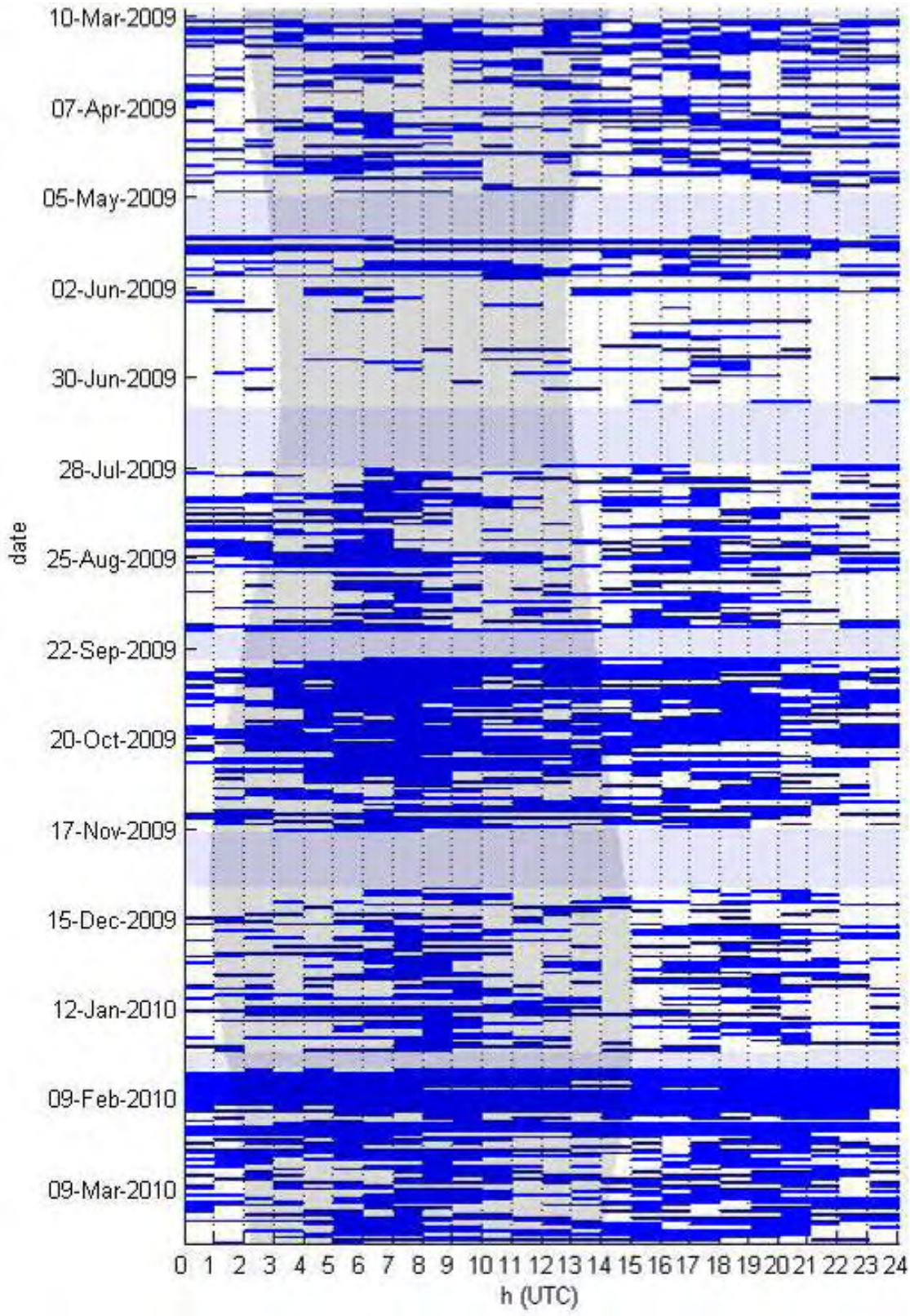
Risso's Dolphin - Echolocation clicks in One-Minute Bins



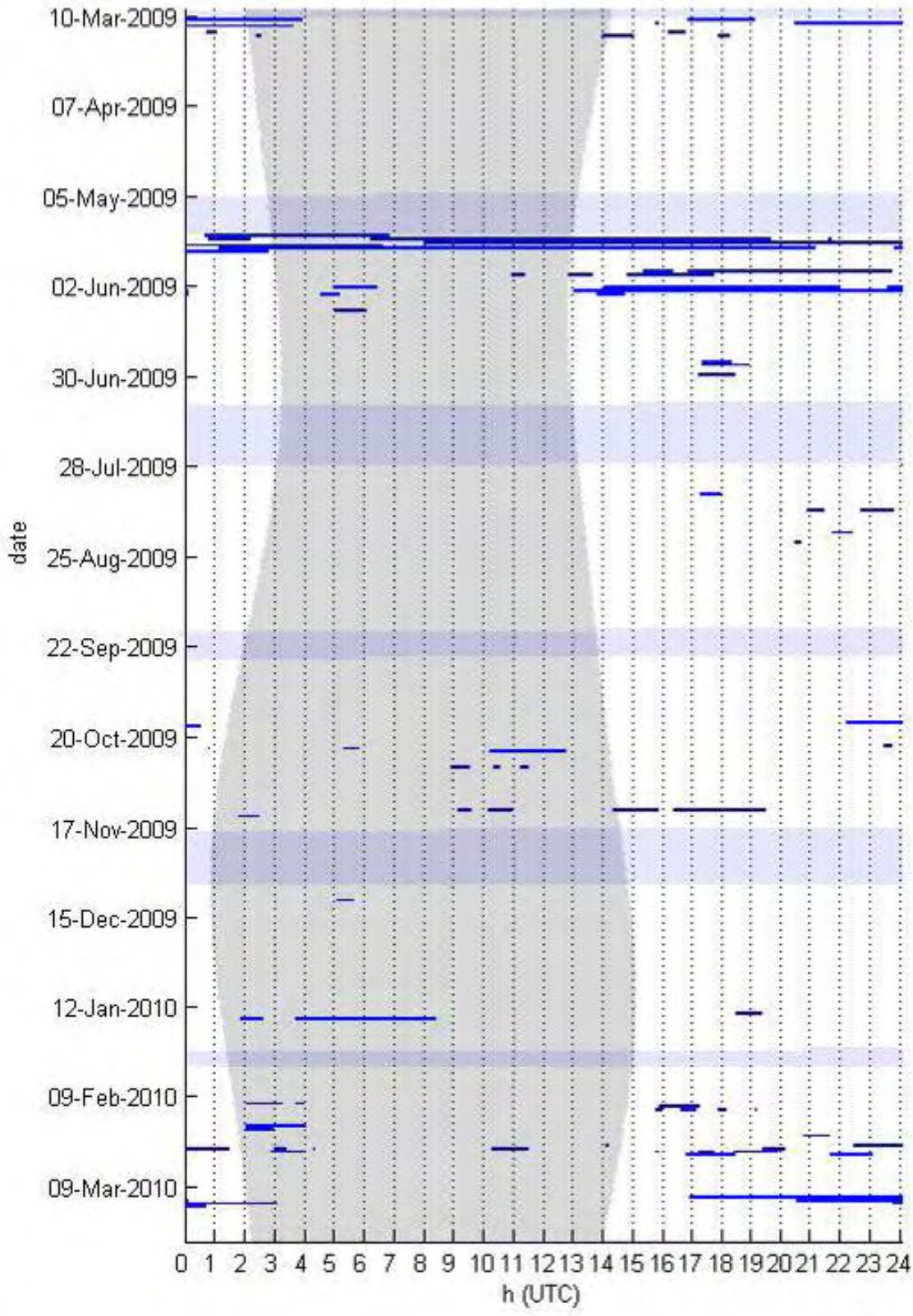
Pacific White-sided Dolphin – All Echolocation Clicks in One-Minute Bins



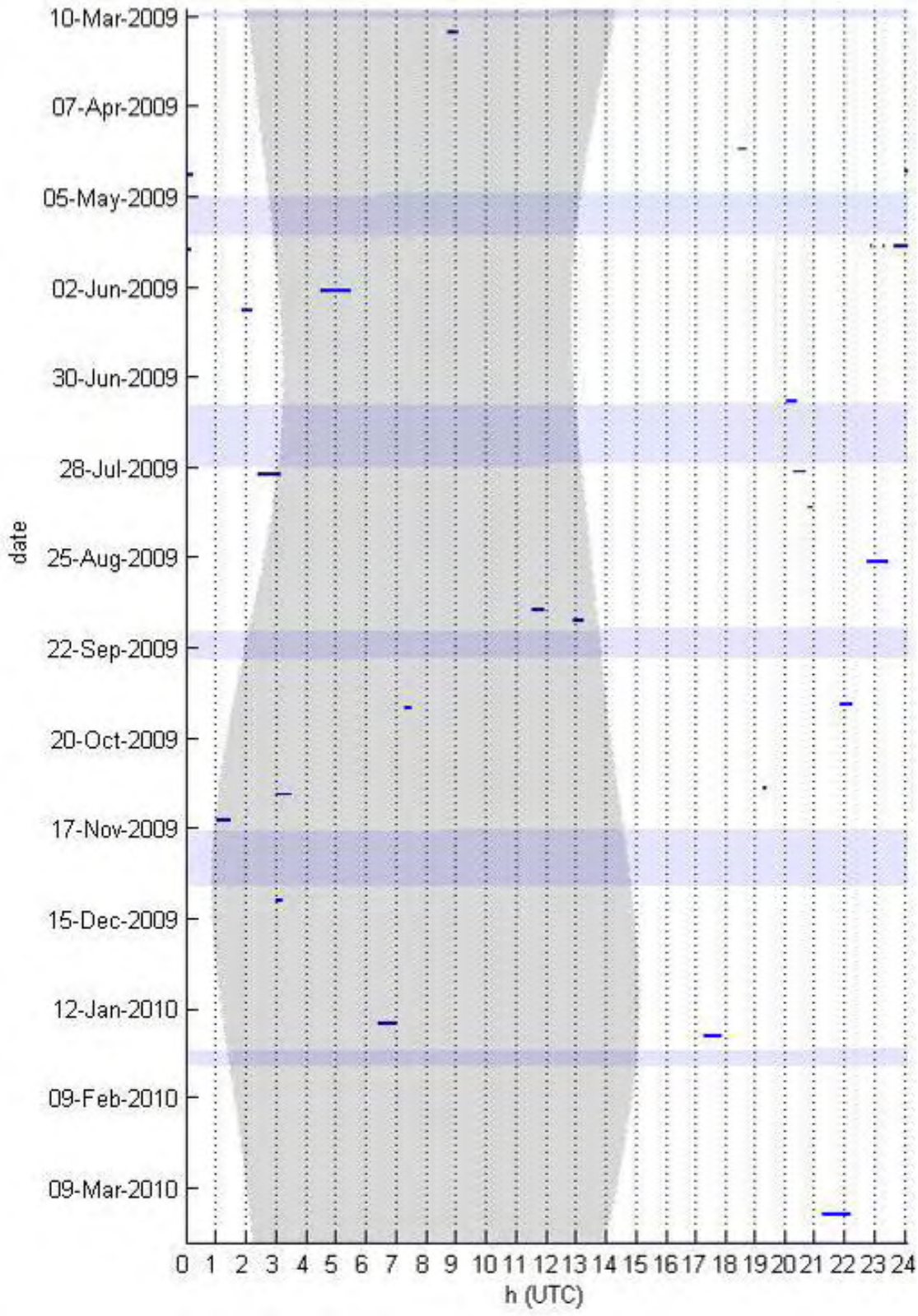
Pinniped - All Call Types in Hourly Bins



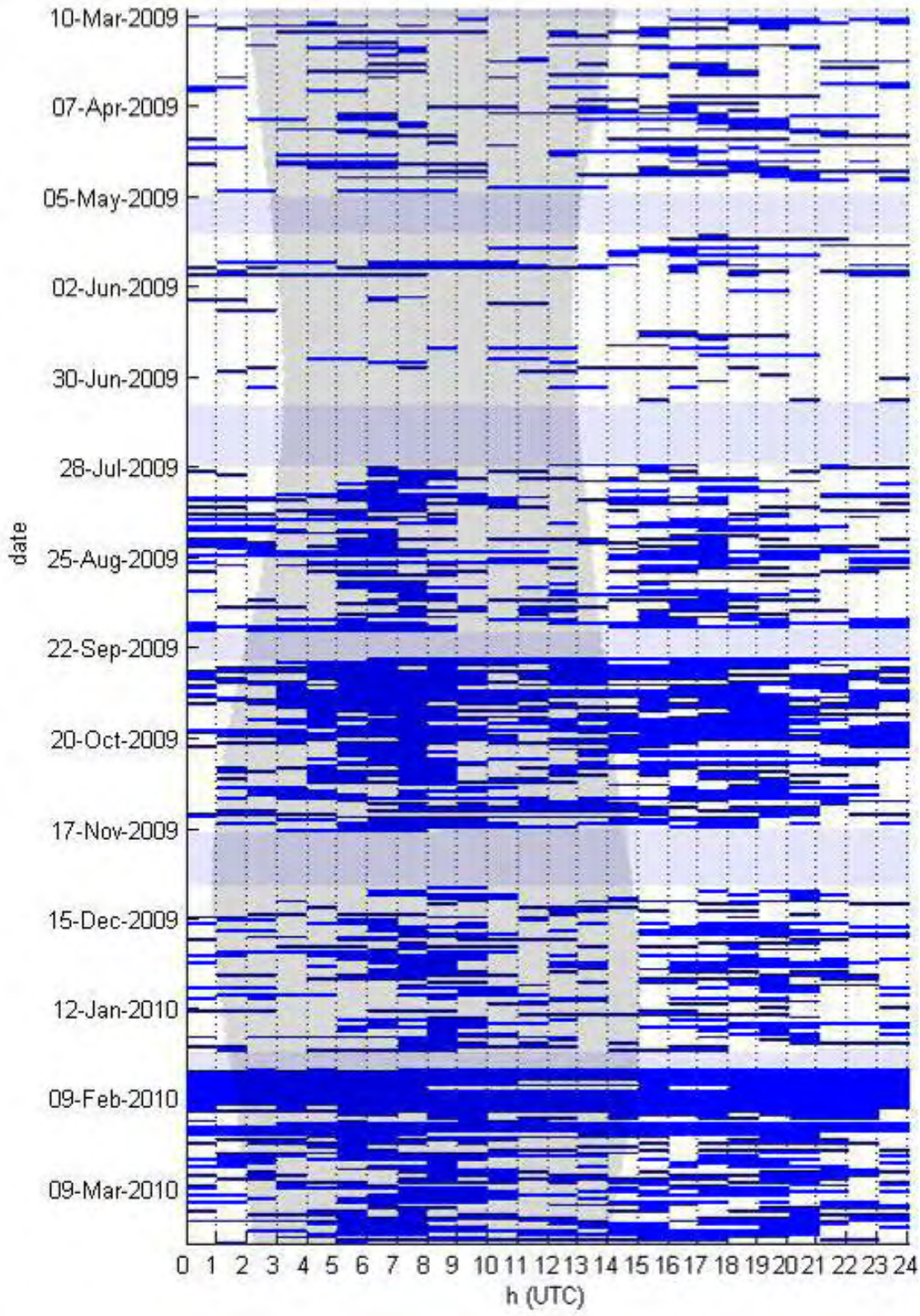
Anthropogenic - All Sound Sources in Hourly Bins



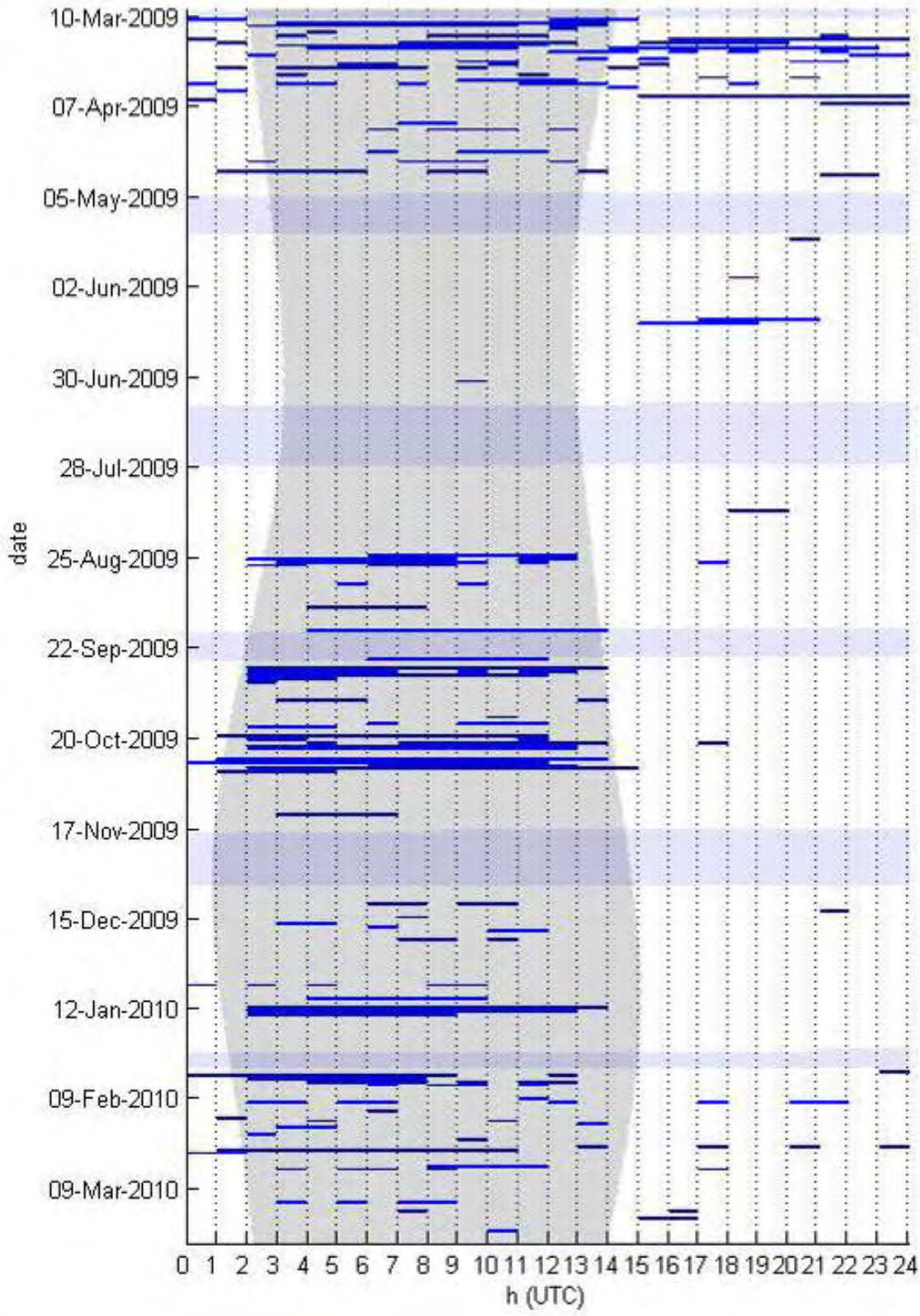
Anthropogenic –Mid-Frequency Active Sonar in One-Minute Bins



Anthropogenic - Echosounder, Various Frequencies, in One-Minute Bins



Anthropogenic - Ship Engine in Hourly Bins



Anthropogenic - Explosion in Hourly Bins